Brandenburg
University of Technology
Cottbus

PhD Thesis

Bottom-Up Approach to Sustainable Solid Waste Management in African Countries

A thesis approved by the Faculty of Environmental Sciences and Process Engineering at the Brandenburg University of Technology in Cottbus in partial fulfillment of the requirement for the award of the academic degree of Doctor of Philosophy (Ph.D.) in Environmental Sciences.

By

M.Sc. Asi Eugene Ndum

from Batibo, Batibo, North West Region, Cameroon

Supervisor: Prof. Dr. –Ing. habil. Günter Busch

Chair of Waste Management, BTU Cottbus, Germany

Supervisor: Prof. Dr. rer. nat. habil. Hans-Jürgen Voigt

Chair of Environmental Geology, BTU Cottbus, Germany

Day of the oral examination: 12.02.2013

Brandenburgische
Technische Universität
Cottbus

DOKTORARBEIT

Bottom-Up – Ansatz für eine nachhaltige Abfallwirtschaft in afrikanischen Ländern. Ein Analyse existierender Systeme

Von der Fakultät für Umweltwissenschaften und Verfahrenstechnik der Brandenburgischen Technischen Universität Cottbus zur Erlangung des Akademischen Grades eines Doktors der Philosophie (Ph.D.) in Umweltwissenschaften genehmigte Dissertation.

Vorgelegt von

M.Sc. Asi Eugene Ndum

Aus Batibo, Batibo, Nordwesten Region, Kamerun

Gutachter: Prof. Dr.-Ing. habil. Günter Busch

Lehrstuhl Abfallwirtschaft der BTU Cottbus, Deutschland

Gutachter: Prof. Dr. rer. nat., habil. Hans-Jürgen Voigt

Lehrstuhls Umweltgeologie der BTU Cottbus, Deutschland

Tag der mündlichen Prüfung: 12.02.2013

Declaration

I hereby declare that this dissertation is the result of my own investigation and relentless efforts, except where otherwise stated. The research was carried out at Brandenburg University of Technology (BTU) Cottbus under the supervision of Prof. Dr. –Ing. habil. Günter Busch, Chair of Waste Management.

This work has not been accepted for any degree, and is also not being concurrently submitted for any other degree.

ASINDUM

Asi Eugene Ndum

Date: 18.07.2013

Acknowledgement

Foremost, I would like to express my sincere gratitude to my supervisor Prof. Dr. –Ing. habil. Günter Busch for his motivation and immense contribution of knowledge. I could not have imagined having a better supervisor and mentor for my PhD. His guidance and support was invaluable to the success of this work.

My sincere appreciation goes to Prof. Dr. rer. Nat., habil. Hans-Jürgen Voigt for his supervision and support. His encouragement meant much to me.

Besides my Supervisors, I would like to thank Prof. Dr. Christina Dornack for her encouragement and cordial support.

My sincere thanks to Ms. Susann Handke for her assistance and hospitality. During Masters, you were there to give me the great push I needed. It was the joy of my heart when you got the offer to serve as secretary in the Chair of Waste Management. You've played a major role and I vote you as one the best secretaries on BTU Campus. You've always been a great friend!

Sincere appreciation to Dr.Yinda Goodwin Sendze of the Department of Environmental Science, University of Buea-Cameroon. My research trips to Cameroon were successful because of your great support and collaboration. You've always been a great friend!

Special thanks to the Mayor of Buea Council and workers at the Sanitation department who gave me the authorization to carry out this research in Buea city. Thanks for your immense support and collaboration. Will always remember Buea for your hospitality.

Thanks to Ms. Beate Körner – DAAD Bonn. Your support and hospitality put joy in my heart and on my face as an international student in German and BTU in particular.

Sincere gratitude to my special friend Mr. Nsiah Jacob, TU Berlin for all the technical contributions to my work.

Great thanks to DAAD in collaboration with the International Office for support fund under the STIBET programme in 2008 that made my first field trip successful.

Sincere gratitude to Dr. Jennifer Yanco and West African Research Association (WARA) for 2009 travel grant award. This huge financial gain and your constant checking on me to know about the progress of my work have yielded an academic fruits. I'm forever grateful!

Thanks to Professor Braden Allenby, Arizona State University (Ira A. Fulton School Of Engineering) U.S.A for the grant and opportunity given me to be a part of 2009 Symposium on Industrial Ecology for Young Profession. Was a great opportunity to Internationalize and improve on professional skills.

My sincere gratitude goes to Prof. Kari Heiskanen, Aalto University-Helsinki Finland for the grant and priviledege to be one of the selected few in the world to participate at the International Summer Symposium of Sustainable Systems (4S). 4S shaped my way of appreciating sustainable system. The number of days spent on your campus was so enriching.

Special thanks to Prof. Ronald L. Mersky, Widener University. It was an awesome opportunity to participate at the 25th International Conference on Solid Waste Technology and Management. Would have missed greatly for not being there. Thanks to the Department of Civil Engineering for organizing this great conference yearly.

Special thanks to Prof. Dr. rer. Nat. Manfred Wanner and ERM-PhD colleagues for your enormous contributions during research seminars.

Thanks to Jubilee Campus Team and members of Gospel Evangelical Worship Center Berlin for your constant prayer support and words of encouragement. You lifted me up in my most difficult moments.

I would like to thank my father-in-law Justice Nkengla for hosting me in Buea during my research trips. You were just so wonderful and placed everything at my disposal to facilitate my research. Will be forever grateful

Thanks to my parents for their huge contribution to my academic pursuit from primary to PhD level. You sacrificed everything to help me come this far in life. To my siblings, you were all there for me with every form of encouragement.

Last but not the least; to my wife and son, I cannot overemphasize how much sacrifice you made and love you showed to me.

Dedication

This work is dedicated to my parents Pa Jacob & Mme Mary Ndum whose patience never waned to see this dream come true. To my wife Lilian Asi and son Caleb who missed so much of my presence & pleasurable moments by day and by night in order for me to take this mission to completion.

Abstract

The unprecedented population growth, rising in community living standard (changing lifestyle) and urbanization have left most municipalities in African Countries grappling to find viable solutions to their waste management problems (health-pollution-degradation). While improper WM is attributed to the systemic failure of policy makers and municipal authorities to identify the most sustainable approach to dealing with it so as to meet environmental and socio-economic aspirations, on the other hand large development projects funded by international organizations and most developed countries are carried out "from the top down" without taking into consideration the concerns of those who will be directly affected and the impact of public attitudes and behaviours.

This study is not only relevant but also timely in the wake of global economic meltdown and rapid urbanization in order to achieve efficient and cost effective waste management. It is aimed at finding a new approach to involve people of different social, ethnic, gender and religious groups in the reconstruction of local waste management systems creating typical win-win situations. The **objectives** of this research are as follows:

- Investigate how gender (women) affect solid waste planning and the influence of different social status of the community in particular the role of households.
- Examines the level of community involvement in solid waste management in terms of policy formulation, implementation and evaluation.
- Assesses capacity building programs that enhance society's ability to solve waste management problems and identify appropriate technology options.
- Identify the resource potential of waste streams and the extent of waste utilization as a resource.
- Exploring possibilities for initiating small scale businesses at local level in order to alleviate poverty and make waste management a lucrative business.

The case study area Cameroon "Africa in miniature" is used to highlight waste management burdens and challenges which is a characteristic of most African cities. This research sought to answer one principal question: Can top-down approaches in MSW management be successful without sufficient community engagement and sense of ownership? Top-down approaches where considered in terms of policies, technology transfer and know-how.

An integrated methodology was used involving (i) a desk study to review official reports, articles and other relevant literatures (ii) field survey in Cameroon for situation analysis and investigation of WM practices (iii) Household questionnaire survey to investigate the role of households in WM (iv) Habitat scale (premise, neighbourhood & city levels) to form basis for system that is adapted to local condition (v) Waste to cash seminar for stakeholders analysis (vi) Focus group discussion applying CLEAR model to underpin gender participation as drivers of environmental ideas.

The outcome of this holistic investigation reveals a strong concern for a clean environment thus citizens' participation and awareness creation is so vital to take the massage to grass root levels. Municipal waste collection services are more effective when they work in collaboration with community led primary collection from households. It is clear that where a reliable service can be guaranteed communities are willing to pay for it. The willingness to contribute to proper WM showed that 38.75% of respondents acknowledged the willingness to contribute by transporting their garbage to the communal container, 52.5% majority indicated willingness to contribute by paying an amount agreed upon by the community for solid waste collection services, 8.75% indicated their contribution to separate recyclables and organic waste. From results, an integration of several factors is vital to increase sustainability.

Although Bottom-Up approach is time consuming, it is the most favourite approach for every rural community. However, it does not undermine the fact that the best implementation in some situations is some sort of a middle ground between Top-down and Bottom-up.

Keywords: Bottom-Up, Top-Down, Sustainability, Formal & Informal sector, Municipal Solid Waste Management, Public Participation, Local knowledge

Zusammenfassung

Das beispiellose Bevölkerungswachstum, der steigende Lebensstandard in der Gesellschaft (Veränderung des Lebensstils) und die Urbanisierung veranlassten die meisten Gemeinden in afrikanischen Ländern sich mit tragfähigen Lösungen für ihre abfallwirtschaftlichen Probleme (Gesundheit –Verschmutzung – Abbau) auseinandersetzen. Ungeeignete Maßnahmen in der Abfallwirtschaft sind meist mit dem systemischen Versagen der politischen Entscheidungsträger und kommunalen Behörden verbunden. Die Maßnahmen sollen eigentlich einen nachhaltigen Ansatz identifizieren, der Erwartungen an Umwelt-und sozioökonomischen Zielen erfüllt. Auf der anderen Seite werden große Entwicklungsprojekte von internationalen Organisationen und Industrieländern finanziert und "top-down" durchgeführt, ohne die Anliegen derer zu berücksichtigen, die direkt von den Auswirkungen der öffentlichen Einstellung und Verhaltensweisen betroffen sind.

Diese Studie ist nicht nur wichtig, sondern auch zeitlich im Kontext der globalen Wirtschaftskrise und einer raschen Urbanisierung relevant, um eine effiziente und kostengünstige Abfallentsorgung erreichen zu können. Sie zielt darauf ab, einen neuen Ansatz für Menschen zu entwickeln, der unterschiedliche soziale, ethnische, sexuelle und religiöse Gruppen in den Wiederaufbau der örtlichen Abfall-Management-Systeme einbezieht und damit eine typische Win-Win-Situationen erzeugen soll. Die Arbeit soll folgende Aspekte beantworten, bzw. bearbeiten:

· Wie wirkt sich zum einen das Geschlecht (Frauen) auf die Planung in der Abfallwirtschaft aus und welchen Einfluss hat zum anderen der unterschiedliche soziale Status der Gemeinde insbesondere die Rolle der Haushalte?

· Wie hoch ist die Beteiligung der Gemeinde in der Abfallwirtschaft im Hinblick auf die Konzipierung, Durchführung und Auswertung?

· Abschätzung von Programmen zum Capacity-Building, die die Fähigkeit der Gesellschaft verbessern sollen, Probleme in der Abfallwirtschaft zu lösen sowie geeignete Technologie-Optionen zu identifizieren.

· Welches Ressourcenpotenzial von Abfallströmen und welches Ausmaß einer Nutzung von Abfällen als Ressource können identifiziert werden?

· Erarbeitung von Möglichkeiten zur Initiierung von Kleinunternehmen auf lokaler Ebene, die zum einen Armut bekämpfen und zum anderen die Abfallwirtschaft zu einem lukrativen Geschäft werden lassen.

Die Beispielregion Kamerun – „Afrika in miniature“ – wird verwendet, um die Belastungen und Herausforderungen hervorzuheben, die sich aus der Abfallwirtschaft ergeben und charakteristisch für die meisten afrikanische Städte sind. Diese Arbeit soll eine grundsätzliche Frage beantworten: Können „top-down“-Ansätze in der Siedlungsabfallwirtschaft ohne ausreichendes Engagement der Gemeinde und ohne ausreichende Wahrnehmung der Eigentumsverhältnisse erfolgreich sein? „Top-Down“-Ansätze wurden hinsichtlich Politiken, Technologietransfer und Fachkenntnis betrachtet.

Eine ganzheitliche Methode wurde angewandt, die folgende Aspekte beinhaltete: i) Studie offizieller Berichte, Artikel und anderer relevanter Literatur, ii) Feldstudie in Kamerun zur Situationsanalyse und Untersuchung von Praktiken in der Abfallwirtschaft, iii) Haushaltsumfragen mittels Fragebögen zur Untersuchung der Rolle der Haushalte in der Abfallwirtschaft, iv) Berücksichtigung der Standortgrößenordnung (Laden-, Nachbarschaft- und Stadt-Ebene) um eine Basis für ein System erarbeiten zu können, dass an lokale Bedingungen angepasst ist, v) Seminar zur Thematik „Waste to cash“ für eine Analyse relevanter Interessengruppen, vi) Gruppendiskussionen unter Anwendung des CLEAR-Modells, um die Beteiligung beider Geschlechter als Antreiber ökologischer Ideen zu untermauern.

Das Ergebnis dieser holistischen Untersuchung offenbart eine große Sorge um eine saubere Umwelt. Daher sind Bürgerbeteiligung und Bewusstseinsbildung für eine Weiterentwicklung auf Basisebene entscheidend. Sammelsysteme für Siedlungsabfälle sind effektiver wenn eine Zusammenarbeit mit der Gemeinde über eine Primärsammlung von Haushalten besteht. Es ist offensichtlich, dass Gemeinden bereit sind, für Serviceleistungen zu zahlen, wenn sich der Service als zuverlässig herausstellt. 38,75% der Befragten bestätigten ihre Bereitschaft, sich an einer angemessenen Abfallwirtschaft zu beteiligen, indem sie ihre Abfälle zu kommunalen Sammelbehältern transportieren würden. 52,2% der Befragten gaben ihre Bereitschaft an, indem sie einen abgestimmten Betrag an die Gemeinden für die Sammlung von Siedlungsabfällen zahlen würden, während 8,75% der Befragten ihre Bereitschaft darüber ausdrückten, recycelbare und organische Abfälle trennen zu wollen. Aus diesen Ergebnissen kann gefolgert werden, dass die Einbindung verschiedener Faktoren unerlässlich ist, um Nachhaltigkeit zu steigern.

Obwohl „bottom-up“-Ansätze zeitintensiv sind, stellen sie die favorisiertesten Ansätze für jede ländliche Gemeinde dar. Die beste Implementierung wird durch eine Art Mittelweg erzielt zwischen autoritären Ansatz und einem eher zwangloseren Ansatz, der von vielen Regierungen zur Regulierung der Abfallwirtschaft herangezogen wird. Diese Tatsache wird von den Ergebnissen dieser Arbeit nicht untergraben.

Schlagworte: bottom-up, top-down, Nachhaltigkeit, formeller und informeller Sektor, Abfallwirtschaft, Beteiligung der Öffentlichkeit, Lokales Wissen

Bottom-Up Approach to Sustainable Solid Waste Management in African Countries: The case of Buea- Cameroon

Table of Contents

List of Figures

List of Tables

Abbreviations

ADB	African Development Bank
ACEPESA	Asociacion Centro Ejecutor de Proyectos Economicos y Salud
CIA	Central Intelligence Agency
DCD	Department of Constitutional development
DFID	Department For International Development
EPA	Environmental Protection Agency
EU	European Union
FSD	Foundation for Sustainable Development
Habitat	United Nations Centre for Human Settlements
HYSACAM	Hygiene and Sanitation Company
IFIC	Institute for International Cooperation
JICA	Japan International Cooperation Agency
ISSWM	Integrated Sustainable Solid Waste Management
MEWR	Ministry of Environment and Water Resource
NGOs	Nongovernmental Organizations
NEA	National Environment Agency
OECD	Organization for Economic Cooperation and Development
PSDU (French)	Sustainable Development and Poverty Reduction Unit
SWM	Solid waste management
SD	Sustainable development

UNEP	United Nation Environmental Protection
UNDESA	United Nations – Department of Economics and Social Affairs
UNDFW	United Nations Development Fund for Women
UNFCCC	UN Framework Convention for Climate Change
USGS	United States Geological Survey
WMH	Waste Management Hierarchy

CHAPTER ONE: INTRODUCTION

1.1BACKGROUND

Rapid urban development facing developing countries including Cameroon has come with serious environmental challenges concerning solid waste management. Solid waste arising from domestic, social and industrial activities is increasing in quantity and variety as a result of growing population, rising standards of living in most African countries and the development of technology (Dickerson, 1999)

Solid waste management (SWM) is a common term that encompasses a wide variety of activities and practices that describes unwanted residues of any given culture. All forms of human activity result in the generation of waste which can cause changes in the environment and harm to animals, plants and ecosystems. However, only a careful management will limit damage done to the environment and conserve scarce resources (Powell, 2001).SWM is an important facet of sustainable development for any country and global initiatives greatly support the prioritizing of SWM.

According to UNDESA (2005), Agenda 21 of the Rio Declaration on Environment and Development affirms that environmental sound management of waste is one of the environmental issues of major concern in maintaining the quality of Earth's environment especially when it comes to sustainable development in all countries. The United Nations Millennium Development Goals (MDGs) by the September 2000 UN Millennium Submit reaffirmed sustainable SWM. On like in Agenda 21, MDGs indirectly advocate sustainable SWM in the seventh goal which addresses environmental sustainability. This aims to foster the integration of the principles of sustainable development (SD) into country policies and programs (UNDP, 2007).

Waste generation dates back as far as man started roaming the earth. The abandonment of the nomadic life in later years led to the creation of permanent communities. Until recently, waste was given a low priority in most municipalities, conference rooms and government offices responsible for public health and safety. (Pichtel, 2005). It was only way into the 19th century

that the idea of collecting and disposing of garbage in a systematic fashion became part of the general drive to improve public health (Vlachos, 1993). In today's cities solid waste is removed and is either sent to disposal or is reprocessed for subsequent use.

The fundamental environmental issue in industrial and developing countries throughout the world is how to best identify and manage waste streams (Twardowska, 2004). As urbanization continues to take place, the management of solid waste poses major public health and environmental problems in urban areas of many developing countries. Thus development must be sustainable such that it is based on an integrated approach and interaction between social, cultural, economic and ecological. Sustainability therefore means reducing the ecological footprint while simultaneously improving the quality of life – for ours and future generations – within the capacity limits of the globe (Lundström, 2007). SWM has been an integral part of every human society and policies vary both within and between developing countries. The characteristics and quantity of MSW arising from domestic, commercial, and industrial activities in a region is not only the result of growing population, rising standards of living and technology development, but also due to the abundance and type of the region's natural resources (Dongqing et. al, 2010)

The approach for SWM varies and should be compatible with the nature of a given society. Many studies on MSW management in developing countries have revealed that waste quantities and composition vary according to the characteristics of a place, and the management must be adapted to certain limitations common to these settings. Some of these limitations are attributed to the immaturity of MSW management discipline in developing countries on the one hand and new laws to regulate solid waste not systematically enforced because of a lack of clarity in the duties and liabilities of the parties involved. On the other hand, indigenes depend on the capability of municipal authorities for municipal solid waste collection and disposal (Puentes, 2004).

One of the most promising methods of environmental protection in low income settlements is community based waste management. This approach is concerned about radical change of attitude and habits towards solid waste collection and disposal. It places more emphasis on the fact that more income opportunities in recycling should be created as the only way to have sustainable waste collection service. However, for this to become a reality, community leaders

and organizations must be able to initiate and enforce lasting changes of habits. Thus the ability of formal and informal leaders to influence and organize their community members is of primary importance underlying such a successful waste management program (Sohail, S. et al., 1996). It is worth noting that garnering the benefits of every aspect of environmental cleanliness and protection serves as a drive to holistic waste management. Thus treating every waste as a resource will be pivotal to bringing sustainability.

1.2 Statement of the problem

Urban development in African and Cameroon in particular, while having brought significant benefits to the people such as employment and economic development has caused environmental problems. An improvement in the quality of life is accompanied by an increase in resource consumption and large amount of waste generated from various urban centers every day. The high volumes of waste and management cost involved go beyond the capacities of governments, local councils and other agencies to handle. The deposition and burning of domestic waste causes a profound strain on the environment; potential contamination of ground water resources, organic and inorganic pollution of nearby surface water and carbon dioxide release from landfill and incineration plants contributing to global heating.

The rapid increase in volume and types of solid waste seen in recent times is a result of continuous economic growth, urbanization and industrialization which has become a major problem for national and local governments to ensure effective and sustainable management of waste. Reports reveal that in 2006 the total amount of municipal solid generated globally reached 2.02 billion tones, representing a 7% annual increase since 2003 (Global Waste Management Market Report 2007). It further projects that in 2007 and 2011 global generation of municipal waste will rise by 37.3%, equivalent to roughly 8% increase per year. This is evident in both organizational preparedness to meet the challenge of successful disposal and grave concerns about the variety of new materials which enter the waste streams.

The problem of solid waste in most urban and rural communities in developing countries and Cameroon in particular is manifested in air pollution as a result of the burning of wastes, water pollution due to the dumping of solid waste in waterways and soil contamination

through solid waste accumulations. The volume of garbage that must be stored, collected, transported and disposed of has increased tremendously in recent years. Many urban areas are characterized by piles of rubbish in every open space. The direct cause of this large-scale litter problem is that there is no effective and appropriate way for residents to dispose of their solid waste. According to a 1989 research conducted by the Pan-American Health Organization (PAHO), the smog emanating from two area dumps surrounding Kingston and Spanish Town was monitored. Results showed that particular matter was found to be 4 times higher than the USEPA standard of 260 mg/m^3, with an average of 1,000mg/m3. It has been postulated that this particulate concentration is a leading factor in respiratory tract infections around Kingston, and it can also cause eye ailments and asthma (Haugestad et al.2004).

Many developing urban areas in Cameroon and Buea in particular are characterized by piles of rubbish in every open space. The cause of the large scale litter problem is that there is no effective and appropriate way for residents to dispose of their solid waste. The dense population of these areas makes it impossible for people to bury wastes on their own land and many communities have no collection system to remove wastes, either from individual households or from convenient collection point. When there is a collection system, it is often insufficient. The palmer Development Group 1993 identifies some common problems:

- Too few collections per week,
- Inadequate on-site storage
- Irregular services.

Although there is no overall data on the level of collection services provided in most developing urban areas in Cameroon, it is clear that collection services in many of these areas are ineffective. The lack of space for proper waste disposal and management, lack of necessary technology for collection, transportation and processing of waste for useful purposes and financial constrains of the council to solve the ever-increasing quantity of waste produced from various sources is a cause for concern. The inefficient and ineffective waste management in Buea has resulted low collection coverage and irregular collection services, pilling up of trash (garbage heaps) and burning without air and water pollution control. Molyko contributes the highest bulks of Buea's solid waste generation. Although conditions of waste management are slightly variable throughout the country, there is need to find common factors limiting effective solid waste management in towns and cities of Cameroon.

Open dumping

Uncontrolled dumpsite

Solid Waste Burning

Solid waste stream dumping

Figure 1.1 Portraying waste management problems in Buea

The neglect of the problem of urban solid waste management in most African cities according to Yhdego, 1995 is due to the following factors:

- Stagnating economic developments has meant little investment into waste management which may have been compounded by mis-directed conceptions of inappropriate high level technology.
- The rapid growth of population and alarming rates of urbanization, which mean the profuse manifold generation of solid waste.
- Politicians and bureaucrats seem to subscribe to the out-of-sight, out-of-mind syndrome whereby urban solid waste is dumped away from sight of sensitive areas to the detriment of people who live near dumps.
- The complex nature of societies in African countries and the low standard of living such that some communities cannot implement waste management due to an absence of planning for services in low-income housing developments, particularly in shanty towns.

Garbage becomes a breeding ground for mosquitoes and other flies when left uncovered. It serves as a habour for disease victors. A 1980 report according to Ruby Pap reveals that an outbreak of Typhoid Fever in Savannah-La Mar, Westmoreland, was likely caused by flies that bred in the local dump. Open dump disposal also threatens surface and groundwater resources.

Table 1.1 Some diseases associated with solid waste disposal system in Buea

Disease	**Parasite**	**Disease Vector**	**Breeding Ground**
Malaria	*Plasmodium vivax* *Salmonella typhi*	Mosquitoes from disposal sites	Standing water, ponds, untreated landfills and open dumping
Cholera	*Vibrio cholera*	Mosquitoes from waste disposal sites	Standing water, ponds, untreated landfills and open dumping
Typhoid	*Salmonella typhi*	Infection of humans by	Water borne

		fleas and contaminated food stuff	pathogens
Pneumonia	*Mycoplasma pneumonia*	Inhalation of contaminated air	Polluted air
Bronchitis	*Mycoplasma pneumonia*	Inhalation of contaminated air	Polluted air
Paratyphoi*l*d	*Salmonela paratyphoid*	Sucking blood from human and infected merogoite	Open dumps, standing waters and open ponds

Source: Mount Mary Hospital, 2004

One of the oft-cited barriers to improved waste management is said to be information failure: the lack of basic data on how much waste is produced.

According to Pearce 1994 report**,** developing countries face several major problems as a result of solid waste such as;

- Health hazards from uncollected waste
- Health hazards from collected but poorly disposed of waste
- Economic burden of waste disposal on towns and cities.

The limitation of data on the composition of MSW in developing countries and wide variability of available figures from country to country is a setback to waste management.
Thus towns find it difficult in providing infrastructure and service that can keep pace with the fast growing urban population which poses serious challenges to policy makers in the local government to make necessary adjustments in their service programmes. One of the most pressing problems facing municipalities is the inefficient and long-term disposal of solid waste. The degree of human risk associated with solid waste handling and disposal varies in all countries although some problems are more severe and widespread in developing countries. Based on Cointreau (1996), these problems are classified into four main categories:

1) The presence of human fecal matter,

2) The presence of potential hazardous industrial waste,
3) The decomposition of solids into constituent chemical which contaminate air and water systems and
4) The air pollution caused by consistently burning dumps and methane release.

1.3 Research Aim & Objectives

1.3.1 Aim

This Research is aimed at finding a new approach to involve people of different social, ethnic, gender and religious groups in the reconstruction of local waste management system, creating typical win-win situations.

1.3.2 Objectives

- Investigate how gender (women) affect SW planning and the influence of different social status of the community in particular the role of households.
- Examines the level of community involvement in solid waste management in terms of policy formulation, implementation and evaluation.
- Assesses capacity building programs that enhance society's ability to solve waste management problems and identify appropriate technology options.
- Identify the resource potential of waste streams and the extent of waste utilization as a resource.
- Exploring possibilities for initiating small scale businesses at local level in order to alleviate poverty and make WM a lucrative business.

1.4 Research Questions and Hypothesis

1.4.1 Question

- To what extent can waste be avoided, reused or recycled if women are the pillars/ and propagators of environmental ideas?
- Is the role of scavengers in waste reduction significant?
- Can top-down approaches in MSW management be successful without sufficient community engagement and sense of ownership?

The research goal and objectives above will be achieved through:

- Review of available literature, data and relevant information on waste management projects and policies both national and international.
- Formal and informal interviews with community leaders, religious leaders, women groups and minority groups.
- Formal and informal interviews with solid waste management officials and discussion with local NGOs
- Administration of questionnaires to households and institutions to assess public participation in programmes, policies and various waste management practices.
- Focus group discussions with homogenous group of participants
-

1.4.2 Hypothesis

- Decision making process and daily waste operations is achievable through the full integration of women.
- Identification of resource potential of waste streams will be possible in Buea to avoid 40 percent of waste by recycling and recovery.
-

1.5 Justification of the Study and Limitation

1.5.1 Justification

It is expected that the findings of this study will enable policy makers make wise decisions regarding waste management that will benefit local communities. The study will raise an awareness that will enhance initiatives to reduce the problem, highlighting the role of different stakeholders and extent to which they can be active in addressing it. This dissertation is also relevant to international agencies with strong financial and technical background, not leaving out national, small and medium enterprises interested in waste management. This information will help locals identify specific income generating activities thus making waste contributes to poverty reduction and as a result, meeting Millennium Development Goals (MDG).

1.5.2 Limitation

There was a lack of availability of information from the municipal staff and ineffective coordination during the field study work. Basic statistics of the number of communal containers of waste disposed of weekly and waste quantity were lacking.

CHAPTER 2: LITERATURE REVIEW

2.1 GLOBAL SIGNIFICANCE

Internationally, the focus on waste management has been on innovative recycling technologies, disposal options such as incineration, and the controversies surrounding disposal site selection(landfills & Incineration) in first world communities. However, cost reduction and environmental products are the primary issues (Korfmacher, 1996)

Increasing population, urbanization, industrialization, faced by developing countries in Africa, Asia, South America, are all pointing out to further increases of refuse. Urbanization induces a consumer based society whereby an increase in concentration of people and industrial/commercial development implies an accumulation of waste which needs to be properly managed and safely disposed of.

The genesis of the problem with the disposal of waste dates back to the time when humans first began to congregate in tribes, villages and communities and the accumulation of waste became a consequence of life. Thus the littering of food and other solid wastes in medieval towns led to the breeding of rats and the outbreak of the plague epidemic which killed half of the Europeans in the 14^{th} century and caused many subsequent epidemics and high death tolls (Tchobanoglous et al. 1977).

Solid waste management is one of the main responsibilities of both urban and rural communities and the fundamental objective of solid waste management programmes is to minimize the pollution of the environment as well as utilizing the waste as a resource. Even though per capita waste generation rates in developing countries is less than in higher-income countries, the capacity of the responsible local authorities to manage waste from collection, to recycling or reuse and disposal, is limited(Barton, et. al., 2007). Targets can be achieved using methods that can be afforded by the community over the long term and with less risk to the persons involved. An input of universally valid skills or techniques, or a set of similar culture-neutral attitudes defines management itself, while management of waste requires particular kind of intellectual insight, which would be expected to yield value specific solutions to local problems (Kapoor, 2009).

A research carried out by Couth, et. al (2010) reveals that the average organic content for urban municipal solid waste in Africa is around 56% and its degradation is a major contributor to greenhouse gas emissions. Rapid population growth over-whelms the capacity of most municipal authorities to provide even the most basic services. Adequate municipal solid waste management is much more than a technological issue – it involves other aspects such as institutional, social, legal, and financial. It also involves coordinating and managing a large workforce and collaborating with many involved stakeholders as well as the general public (Zurbrugg, 2003)

Table 2.1 Percentage of population living in urban areas – with projections for 2015

Region	**1950 (%)**	**1975(%)**	**1995(%)**	**2015(%)**
Africa	14.6	25.2	34.9	46.4
Asia	15.3	22.2	33.0	45.6
Latin America	41.4	61.2	73.4	79.9
Industrial countries	54.9	69.9	74.9	80.0
World	29.7	37.8	45.3	54.4

Source: Adapted from U.N. 1998

Low income areas normally have the highest population densities and the lowest level of municipal solid waste service provision **(**Louigueur, 2007**).** What makes management difficult is the fact that most of the poor live in rapidly growing, spontaneous, and often illegal settlements outside government control which public providers may be restricted from serving by law [1]

It is worth mentioning that poor sanitary conditions in low-income neighborhoods pose a health threat not only to residents, but also to the wider population. According to Vaishali (2009) much of the waste generated worldwide (57-85%) where primarily disposed in landfills including open and engineered landfills.

[1] Beyond Boundaries – PPIAF/ADB Manila:2002,p.6

Table 2.2 Percentage of world wide used waste disposal methods

Continent	**Percentage of waste disposed by**					
	Recycling	**Sanitary landfill**	**Open Dum**	**Incineration**	**Open Burning**	Others
Africa	3.9	29.3	47	1.4	9.2	8.4
Asia	8.5	30.9	50.9	4.7	1.7	4.5
Europe	10.7	27.6	33	13.8	11.8	4.4
N. America	8.1	91.1	0	0	0	0
Latin A.	3.2	60.5	34	2	5.5	2

Source: Vaishali, 2009

Methods of solid waste management vary greatly with types of wastes and local conditions. Therefore, the designing of waste management systems should take into consideration the fundamental goals, a clear analysis of local conditions and factors, an understanding of the full range of technology options that are available, and an awareness of the traditional wisdom and systems that the local people have developed (CED, 2003). The disposal of municipal solid waste is one of the more serious and controversial urban issues facing local governments in most developing nations. Per capita generation of garbage continues to surge despite innovative technologies, production decisions and market strategies that have helped in better managing solid waste.

The level of economic development and the quantity of solid waste generated is a function of the population.

Table 2.3 Global perspective on solid waste quantities

	Generation Rates Kg / Capita / Day		
	Low-income country	**Middle-income country**	**High-income country**
Mixed Urban waste – large city	0.5 to 0.75	0.55 to 1.1	0.75 to 2.2
Mixed Urban waste – small to medium city	0.35 to 0.65	0.45 to 0.75	0.65 to 1.5
Residential waste only	0.25 to 0.45	0.35 to 0.65	0.55 to 1.0

Source: Cointreau-Levine, 2000

Waste can be classified based on the source or industry that generates the waste stream. Municipal solid waste (MSW) has grown in volume as the world's population has grown and become more urbanized. The composition of MSW depends on a number of factors such as the lifestyles of the population, their relative standards of living, general consumer patterns, and the level of technological advancement of a particular country (Nicholas, 2003). It is a common knowledge that waste is nothing but useful material at wrong place and there is no material in the world which is not useful in one-way or the other.

Waste management has now become a pressing concern for industrial societies because they produce large volumes of waste as a result of economic growth and lifestyle choices. Waste management technologies like landfilling and incineration do not offer a complete solution to this problem. The attitude of people towards waste changes as types of wastes are changing. This has brought awareness to people that the solution lies in using waste as a resource rather than to be destroyed. Public awareness and attitudes to waste can affect the population's

willingness to cooperate and participate in proper waste management practices. Information on health risks as a result of deficient solid waste management are important issues which have to be continually communicated to all sectors of the society. Solid waste management is concerned with the generation, on-site storage, collection, transfer, transportation, processing and recovery, and ultimate disposal of solid wastes.

Until last two decades, solid waste management policies and programs in most African cities were formulated and implemented by government agencies without significant public participation. The wind of political and social changes observed by the continent in the early 90s led to the growth of NGOs which have fostered an increase in awareness of environmental issues among the public (Palczynski, 2002).Most Urban and local populations are more concerned with issues surrounding MSW than before (UNEP, 2005). The task of local governments throughout the world especially in urban areas is to ensure the provision of healthy and stimulating environmental for their inhabitants. This global consensus is due to the fact that the local government is the sphere of government closest to the people and responsible for the delivery of municipal services to all its citizens (Hardoy, et al, 1992; DCD, 1999).

A feasibility study on solid waste incineration for the largest cities in Kenya, Malawi and Zimbabwe (DFID, 1999) reveals that 75-80% of municipal solid waste was organic. While in India, 70% was organic (Yedla and Parikh, 2002), and reported values for Dhaka city (Bangladesh) from domestic properties were between 85% and 95 %(JICA, 2005; BCAS, 1998). In developed countries, total organic content is lower, typically 6% of which in some cases only 10% is food waste and the rest is paper and cardboard(Tchobanoglous and Kreith, 2002).

Per capita waste generation for developing countries is lower than average. However, the high rates of urbanization and increasing poverty may have a considerable influence on inter country per capita waste generation. According to Badran and El-Haggar (2006), per capita waste generation from urban areas of Egypt is 0.8kg per day while in rural areas it is 0.3 kg per capita per day.

Table 2.4 SWM in Low and Medium Income Countries

	Low-income Countries	**Middle-income countries**
Waste generation(Kg/person/day)	0.3 to approx. 0.6	0.7 approx.1.1
Collection coverage	Less than 70%	80 to 90%
Disposal costs(US$/person/year)	Less than 1	1-3
SWM expenditure in total municipal budget (%)	15.4 to approx. 38	6 approx. 23,2
Recycling	Informal(metal, glass, plastic, composting)	Formal + Informal(metal, glass, plastic, composting)

Source: Adapted from JICA, IFIC, 2005

SWM costs consume over 20% of municipal budget in most municipalities in low income countries. In some places, urban residents receive only 70% of collection service and disposal is by unsafe open dumping despite the high level of expenditure on SWM (Louiguer, 2007). Solid waste services in LMIC do not satisfy the full demand existing in urban areas. According to Cointreau-Levine (2000), in low-income areas, service sometimes only reaches 10% to 40% of the urban population and in most cases; public solid waste departments often employ large numbers of relatively unskillful and unproductive woks.

The purpose of recent EU policies has been to promote more recycling and energy extraction of products and materials thereby decreasing landfilling and organic fraction not ending up in landfills at all. This comes as a result of negative environmental effects of landfills such as emissions (CO2 and methane) to the air that affects climatic conditions and risk of water pollutant transport. EU Council Directives 1999/31/EC of April 1999(EU Council, 1999), stipulates that waste materials should be separated at source, where recyclable and combustible materials are recovered for recycling and

hazardous waste is phased out from production system. The significance of different options in some developed countries is shown in table below. It is clearly seen that U.S.A is after China regarding sanitary landfill and Japan after Switzerland in incineration.

Table 2.5 Different Treatment Options of MSW (%) in Some EU Countries

Countries	**Incineration**	**Biological Treatment**	**Sanitary landfill**
U.S.A	20	5	75
Japan	72.8	4.2	23
Switzerland	80	-	20
Germany	28	10	62
France	40	22	38
Denmark	70	12	18
Sweden	50	10	40
China	6.9	7.5	85.6

Modified after Ni Mingjing (2006). *Composting, anaerobic digestion, etc.

In Mexico, most of the treatment sites have stopped operating for lack of market, the high operational cost (incineration & recycling) and the bad quality of finish product resulting from composting. The outcome of this is that most of the collected waste is not treated at all and its final destiny lies in the few landfills which comply with the required technological characteristics and disposal sites that are open air dumps. In developed countries, it is worth noting that in spite of having progressed in the creation of waste recycling infrastructure, composting with or without energy generation, the disposal of solid waste in landfills is still very significant. In countries like the Netherlands, waste incineration is a method of final disposal which has been increasing. On the other hand, landfills have decreased considerably from 1,000 active sanitary landfills in the 70s to 47 in 1996(de Jong, 1999). These changes were as a result of the prohibition in 1996 for landfilling combustible waste and higher tariffs for landfilling institute since 1999.

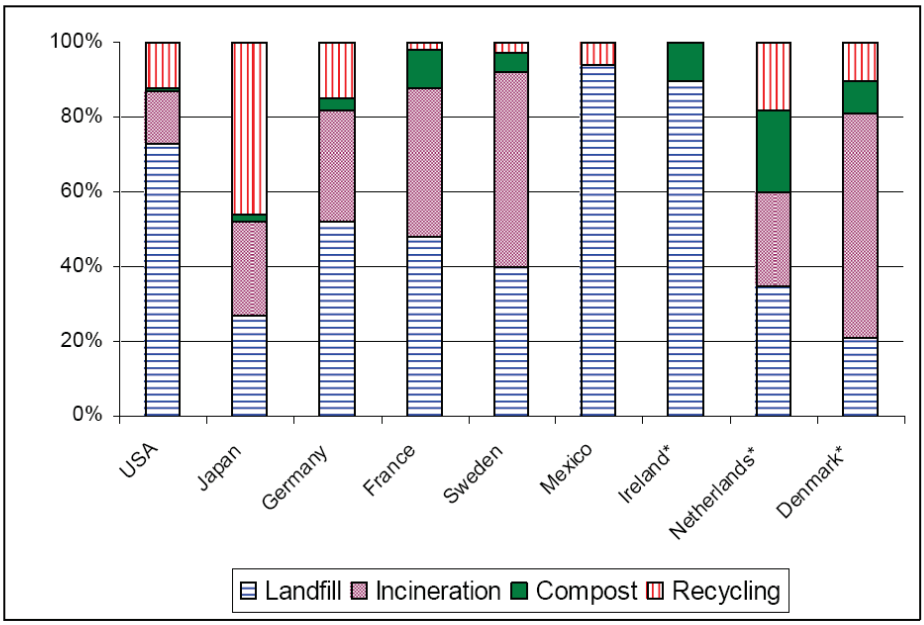


Figure 2.1 Municipal solid waste treatment in various countries (**Source:** Cortinas de Nava, 2001)

A report by Hogland et al. (2005) report reveals that waste generation in low and middle income countries reflect their socio-economic development, urbanization and industrialization. Generally, urban population produces 2-3 times more MSW than rural population as per capita and year.

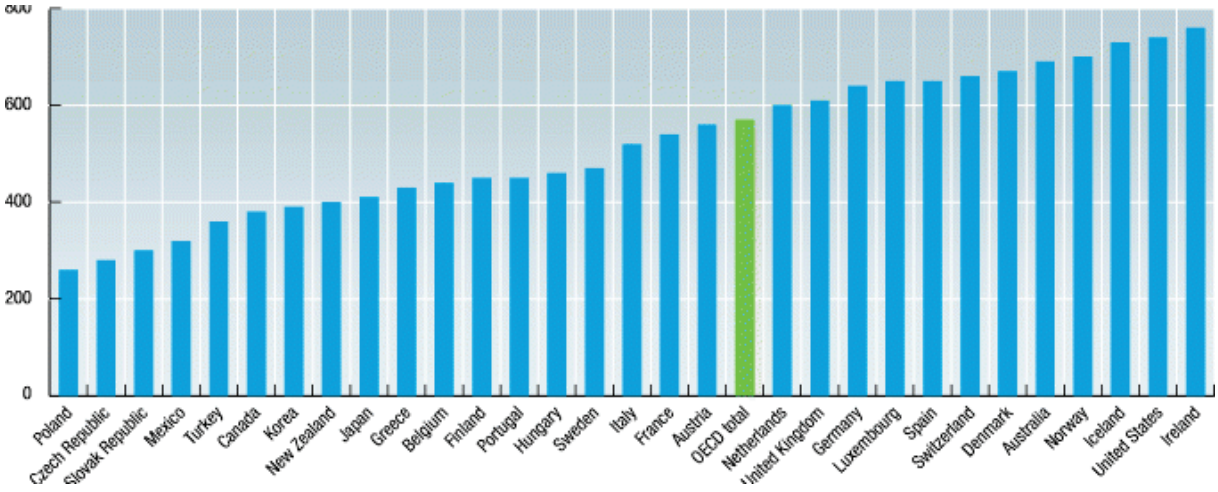


Figure 2.2 Generation of Waste in kg/Person and Year in Different Countries (**Source:** OECD, 2002)

In the continent of Asia, the average generation in low income countries varies from 0.4-0.9 kg/person/day, in middle-income countries, 0.5-1.1 kg/person/day; in high income countries it is 1.1-2.0 kg/person/ day or even more as in Hong Kong: 5.1 kg/person/day (Hogland et al., **2005).** In European waste management hierarchy, landfiling is the last option. In some European countries and continents, this is not yet a reality. About 95% handling of waste in the world is landfilled or dumped into holes in land or directly on the banks of rivers or into the sea (Hogland et al., 2007)

Solid waste has traditionally been a local concern in most countries. Urban solid waste has become a national and international issue because of the growth in waste volumes, the environmental consequences of past disposal practices, and the potential impacts of measures adopted to address the problem of waste disposal (McCarthy, 1994). When considering the advancements in solid waste processing and resource recovery since four decades ago, this leads to both encouraging and disturbing trends.

Until the advent of environmental awareness in the late 60s, landfilling (dumping) and incineration of solid waste were the two principal means of disposal in North America (Robinson, 1986). This saw the closure of many incinerators because of air pollution, dumps were closed or upgraded to sanitary landfillings, and landfilling became a more widely utilized method of disposal. The effects of improper landfilling because of incinerator air pollution and ground water contamination became an **impetus** of waste volume reduction and materials recovery in efforts to conserve landfill space and reclaim nonrenewable resources.

Although using the same methodologies, solid waste management practices still differ widely throughout the world. Japan burns more than 70% of its waste, while more than 84% of American waste goes into landfills (Nicholas, 2003).

The need for landfills has been reduced significantly in Germany in the last decade. Main reasons being that the increasing amount of waste has been channeled for recycling and recovery. The remaining solid waste goes to waste incineration, for co-incineration in coal-fired power-stations, cement kilns and for mechanical and biological treatment. In the 1970s, Germany had 50,000 landfills, while in 2000 the number of landfills had reduced dramatically to 333(Schnurer, 2002; Hempen, 2005). Simultaneously, Germany has seen an increase in the number of waste incineration plants i.e. from seven incinerators with capacity of 718,000 tonnes/year in 1965 to incinerators with capacity of 17,800,000 tonnes/year in 2007(BMU, 2005), and also mechanical-biological plants for municipal waste disposal. The three landfills in Singapore are outside the city limits and for close to four decades, there has been a 2.09 million tones increase in the amount of solid waste generated (NEA, 2008) and thus a significant demand on the waste management and disposal. On this note, landfilling is the last option in the MSW management decision in Singapore. Landfill is reserved for the waste that cannot be treated or disposed of in any way and about 91% of waste collected is incinerated and about 9% along with the as generated from incineration are disposed of at Semakau landfill(NEA and MEWR, 2006)

In low income countries, solid waste generation rates average only 0.4 to 0.6 Kg/person/day, as opposed to 0.7 to 1.8 Kg/person/day in fully industrialized countries. A report by Blight and Mbende (1996) and Arlosoroff (1982) noted several common differences in the composition of solid waste in developing countries:

- Moisture content is 2-3 times greater than developed countries,
- Waste density 2-3 times greater,
- Large quantities of dust, dirt (street sweepings, etc)
- Large amount of organic waste (vegetable matter, etc.)
- Smaller particle size on average than in industrialized nations.

These differences from developed countries should be recognized from two perspectives:

It is worth noting that because of increase population countries in Africa, Latin America and Asia account for nearly 40 percent of annual methane emissions from landfills, which is equal to 37 million metric tons of carbon dioxide equivalent ($MTCO_2e$) or the amount of air emissions from more than 102 million automobiles (EPA,2002)

China is now experiencing a fast increase in solid waste quantities. According to a report by Delvoie (2005), China surpassed the United States as the World's largest waste generator in 2004. By 2030, China's annual solid waste quantities will increase by another 150% - growing from 190 million tons in 2004 to over 480 million tons in 2030. This growing waste stream possesses significant impact on the society, environment and economic development. Waste categorization in China is not always consistent or comprehensive from city to city and this seriously affects the utilization of the database.

2.2 Solid waste management in developed countries

The economically-viable and environmentally – acceptable disposal of municipal solid waste is a major concern in many industrialized countries. The problem facing policy makers in the waste management sector is how to predict the amount and the composition of MSW that is likely to be generated in the near future in order to devise the most appropriate treatment/disposal strategy (Daskalopoulos et al. 1998). The problem of solid waste especially MSW in the industrialized countries has been the cause of growing concern in recent years, becoming one of the main areas of the environmental policy debate. But now, because of the growth in waste volumes, the environmental consequences of past disposal practices, there is raised concerns about the economic viability and environmental acceptability of the current waste-disposal methodologies. In the USA, the goal of the Environmental Protection Agency is a 25% reduction in the deposition of waste at landfills by the year 2000 (Petkov, 1993) In Europe and also the Baltic states, waste is one of the main environmental concerns. The volume of household waste generated will likely be on the increase over the coming years as a result of the increase of amount of packaging used on products.

Comparing the management of urban solid waste in the late 1970s to that of today, it is clear that there is a revolution in waste management underway in most of the industrialized countries. This revolution can be seen in four aspects; (i) revolution in the management

method, away from landfill and toward material recycling and energy recovery. There is a change away from landfill, toward material recycling and energy recovery. (ii) Strengthening of the environmental standards applied to waste management facilities which have led to the closing or upgrading of many existing facilities. (iii) Change in public attitude toward waste in virtually all industrialized countries. At the same time that we have moved toward safer, more environmentally benign methods of management, the public has come to view all methods of disposal as posing unacceptable risks. (iv) a profound change in attitudes toward the proper role of producer industries. This can be seen in the implementation of polluters pays principle and companies being asked by governments to accept increasing levels of responsibility for the waste resulting from consumption of their products. (McCarthy, 1994)

In Europe, the growth has been in recycling more than in energy recovery, but in the United States, both have grown at the expense of landfill. The U.S. EPA projects that material recovery will more than double again in the 1990s, accounting for 30% of total waste management in the 2000. Energy recovery will grow to 21%, leaving only 49% of municipal waste for land disposal (McCarthy, 1993). The approach to waste management in North America has evolved over the years from disposal in open dumps until the 60's, the emergence of sanitary landfills as the preferred method of waste management in the 70's to integrated waste management. The holistic approaches of waste being considered as a resource rather than a liability are being promoted[2]. This waste management philosophy is to ensure the treatment of all wastes as resource material, some suitable for recycling, others for conversion to compost (Hettiaratchi, 2007)

In Japan, only 10% of the land is suitable for residential purposes. The shortage of land in accessible areas limiting the availability of suitable landfill sites is the driving force behind Japan's waste management policy[3].Some 52 million tones of municipal waste is generated each year in Japan, 77.4% of which is incinerated, 5.9% landfilled and 16.7% recycled(Statistical Handbook of Japan, 2003). Source separation of waste by households is well established with separation into either combustible or non-combustible material or recyclable materials such as glass, metal cans, newspapers etc.

[2] New approaches promoted in North America include; bioreactor and biocell approaches of waste disposal and the use of methanotrophy to eliminate greenhouse gas emissions from landfills.

[3] Policies based on waste reduction & recycling of material destined for landfill. The main route for waste disposal is incineration either with or without energy recovery.

2.3 Solid Waste Management in Developing Countries

MSWM is a major responsibility of local governments. The requirement of appropriate organizational capacity and cooperation between numerous stakeholders in the private and public sectors make the task complex. With the importance of waste management to public health and environmental protection, solid waste management in most cities of developing countries is highly unsatisfactory (Schübele, 1996). African countries were given the opportunity by the WHO to prioritize their environment health concerns, the results revealed that while solid waste was identified as the second most important problem(after water quality), but less than 30% of urban populations have access to " proper and regular garbage removal (Senkoro, 2003)

The characteristics of waste in developing countries are obvious:

-The waste is high in organic matter and low in contaminants – highly suitable for composting and anaerobic digestion.

- Waste densities are high - reducing the need for high cost, sophisticated compactor trucks for collection;

- the production rates per household are less than in developed countries – reducing the transport needs; and

- Labour costs are low – increasing the incentives for recycling and scavenging

Table 2.6 Capacity Development in Solid Waste based on JICA, Tokyo

Economic levels of countries	**Low-income countries**	**Middle-income countries**
Activity		
Waste minimization	No organized programs, but reuse and low per capita waste generation rates are common	Some discussions on waste minimization, but rarely incorporated into any organized program
Collection	Service is limited to high visibility areas, the wealthy, and businesses willing to pay	Expanded collection areas. Trucks are used for collection
Recycling	Recycling activities are performed by the informal sector (scrap dealers and waste pickers). Localized markets for recycling are common	While the informal sector is still involved, relatively large machinery is sometimes used for sorting and recycling. Materials are often hauled out of the city as recyclables.
Composting	No organized programs. Wastes including organic matter are not	Efforts toward composting are made at many parts of the city. Large composting plants

	put to good use	are generally unsuccessful. Small-scale composting projects tend to become more successful
Incineration	Not common or successful because of high capital operation cost. High percentage of moisture and inorganic matter call for supplement fuel and have a smaller impact on volume reduction	Incinerators are sometimes used but not common due to economic reasons
Landfilling	Usually open dumping with virtually no environmental controls	Some controlled and sanitary landfills with some environmental controls. Open dumping is still common
Costs	Collection costs represent 80-90% of the SWM budget. Collection fees are regulated by some municipalities, but the quality of collection service is low	Collection costs represent 50-80% of the SWM budget. Some municipalities regulate collection and disposal fees. Innovative arrangement are in place for fee collection

Source: IFIC, 2005

2.3.1 Role of the informal sectors in SWM in developing countries

Millions of people in developing country communities depend on recycling materials from waste for their livelihoods. Poverty reduction and waste strategies on improving recycling rates are elements of the Millennium Development goals. Working with the informal sector to

improve their livelihoods, working conditions and efficiency in recycling is one of the major challenges in waste management in developing countries.

Six decades ago,[4] the informal sector was not taken into consideration by most governments of developing countries. The informal sector plays a major role by subtracting a high proportion of recycled materials from landfilling. According to Suchada et al. (2003) the amount of waste to be disposed of at the landfill is reduced by one-third and is estimated that even up to 90% of recyclable materials are diverted from landfilling.

It is evident that the issues emphasized in solid waste management in third world communities are fundamentally different from those in the first world. The formal[5] and informal sectors play a major role in the recycling systems of developing countries. In order to save natural resources and landfill area, waste recycling and resource recovery are vital. The advantage of the formal sector is that it consists of enterprises which enjoy official recognition, protection, and support because they are registered or given license by the local government or municipality.

[5] Sector that is registered as tax payers

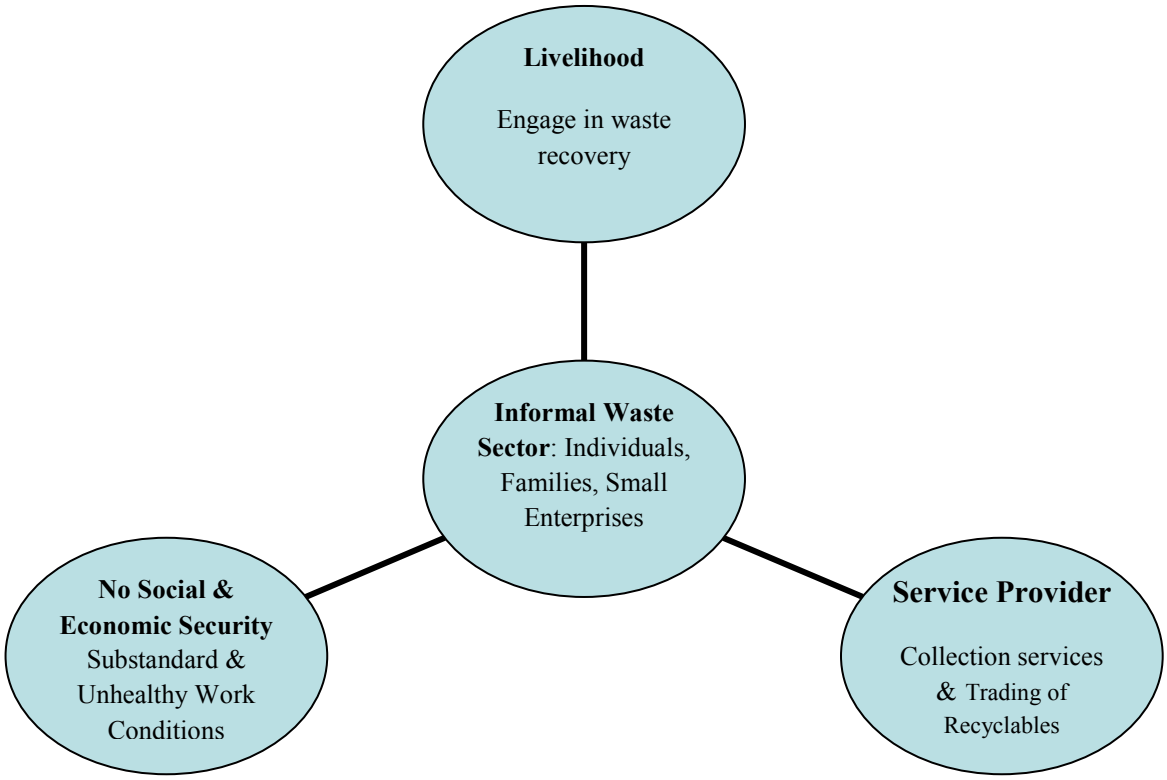


Figure 2.3 The informal Waste Sector (Adapted from Lizette C.Cardenas[6])

Informal recycling occurs in developing countries because of low levels of economic development. This informal recovery of materials from waste constitutes a common activity for disadvantaged population. As a result of this, both scavenging, as an occupation, and scavengers, as people, are poorly understood. The informal sector in solid waste management is significant in the sense that it is self-developed by income earning motivation although its performance is not stable under market-driven mechanism (Amin, 2000). Despite the health risk and social problems associated with informal recycling, it provides significant economic benefits that need to be retained. It is worth noting that informal waste recycling is mostly

[6] Integrating the informal waste sector to the formal solid waste management system

carried out by poor and marginalized social groups who resort to scavenging for income generation and also to improve on their living conditions.

Table 2.7 Role of the informal sector in solid waste management

Category	Method of work	Material
Street pickers	Recovery	Bottles, Cans
Landfill scavengers	Recovery	Bottles, paper, plastic bags, cans other valuables
Collection crews	Recovery	Bottles, cardboard, cans, valuables
Itinerant buyers	Door to door buying (announced collector)	Paper, cardboard, plastic bottles, glass bottles, aluminium cans
Dealers, neighborhood dealers or buyers	Buying(retail)	
Small-scale entrepreneurs	Buying , trading	Metals, iron, steel, paper, cardboard, plastic bottles, glass bottles, miscellaneous
Large-scale entrepreneurs	Buying and large-scale processing technology	

Source: Modified and supplemented on the basis of Romaos and Chifos, 1996

The informal collectors consist of tricyclists, street scavengers, pick-up traders, collection crews, and landfill scavengers .Their role is significant in collecting recyclables directly from various sources around the city.

The informal waste recycling system existing in so many developing countries play a **significant role** in the overall waste management system: reduce the cost of formal waste systems by reducing the quantity of waste for collection thus less money and time spent on collection and transportation, space at disposal sites is preserved and only used for waste with no potential value as recycled materials are diverted for reuse (David C. et al.2006)

Table 2.8 Informal Sector Collection of recovered materials

	Material Recovered by Informal Sector (tones)	**% Collected by the informal Service Providers**	**% Collected by IWBs**	**% Collected by Street Sweepers**	**% Collected by Dump Pickers**	**% Others**
Cairo, Egypt	2,161,534	100				
Cluj, Romania	14,575		2	40	58	
Lima, Peru	529,370	7	27	30	6	30
Lusaka Zambia	5,419			71	29	
Pune, India	117,895	32	34		10	24
Quezon City, Philippines	141, 831		72	16	8	4

Source: WASTE and SKAT, 2007

Informal sector existing today in developing countries is large and dynamic. It is estimated by the World bank that up to 20% of the population in the developing world as many as 30-40,000 individuals in cities like Jakarta, Bangkok, Mexico or Sao Paulo engage in the recovery of recyclables as a primary occupation and as a means of survival(Bartone, 1988:3-5)

The role of Scavengers is so significant in transforming objects of discard into objects of value. Recovery of materials from waste to be reused or recycled has been has been going on for millennia as society continues to satisfy its needs through production and consumption processes. It is worth noting that scavenging takes place at all stages along the waste management system: operating both upstream (collected from waste generators) and downstream (landfill)

In some areas, itinerant buyers purchase materials separated by households or small business while in cities where canals and rivers cross the urban area like Bangkok and Manila, scavengers recover items floating on the water (Medina 1997a: 128).Waste pickers operating on landfill sites, without proper facilities and equipment, are typically exposed to a range of public health and environmental hazards associated with open landfill sites[7] . According to Medina (2006), three categories of waste pickers can be identified, namely:

- **Scavenging for self-consumption**: waste pickers salvage old lamps, desks, sofas, chairs, tables, radios, pots, pans, and other items that can be cleaned, refurbished, repaired and reused.

- **Recovery of materials for sale to consumers**: Entrepreneurs salvage reusable items, such as furniture, appliances, kitchen utensils and construction materials which they then sell to their mostly low-income clientele.

- **Recovery of materials for sale to industry:** Demand for a particular material depends on the kind of industries that are located in each region.

In most high-income areas waste streams tend to contain a greater percentage of recycling materials such as metals, glass, paper, and plastics. Millions of people are employed in collecting, separating, and processing recycled materials thus returning material as a

[7] During heavy rains-stagnant ponds at sites serve as breeding grounds for mosquitoes(vectors of infective agents spreading malaria and filariasis

secondary raw material into industrial production cycles. It is estimated that between 80,000 and 100,000 people work in the informal sector as waste pickers in Delhi-India[8] .

Table 2.9 Estimated numbers of people earning living through informal sector in selected cities

Cities	**Estimated number of people earning living through informal sector**	**Sources**
Delhi	80,000	
Buenos Aires	9,000[9]	
Manila(metro)	17,000[10]	
Bangalore	30,000[11]	Baud et al. 1994
Ahmedabad	20,000[12] (women paper pickers)	Bentley, 1988

[8] Rouse, Jonathan, Ebracing not displacing, CWG on SWM in LMIC and Workshop 2006, Kolkata/India, 2006, p.2.

[9] Jahan-E-Kabadi (2006) Privatising Waste Services: Clearing Waste or People?

[10] CAPS (1992) Recycling activities in Metro Manila. WAREN project. WASTE Consultants. Gouda, the Netherlands

[11] Baud, I., M. Huysman and H. Schenk (1994) New approaches to urban solid waste management: linkages between formal and informal systems of source separation, collection and recycling in Indian cities. University of Amsterdam, the Netherlands

[12] Bentley, E. (1988) Struggle for survival; organizing the paper pickers of Ahmedabad. Mahila SEWA Trust. Ahmedabad, India

According to Oepen (1993), the daily waste production of Jakarta in 1988 was more than 21,000 m^3 and 25% of which was recovered by an estimated 37,000 scavengers. Because of these activities, the city saved $270,000 – 300,000 per month and presently, a minimum of 78 factories use material that has been recovered from waste in their plastic, paper, glass and metal production processes. High recycling rates for glass and paper are significant, about 60-80%. About 90% of the secondary raw material collected by scavengers is waste paper. It is worth noting that in delivering 378 tons of waste paper per year to paper factories for recycling purposes, the scavengers save 6 million trees from being cut down. The money made with solid waste recycling only, some $48.5 million per year outweighs the 0.5 million paid in garbage collection fees.[13]

Scavengers survive in a hostile physical and social environment. In 1992, forty corpses of scavengers were discovered at the Universidad Libre de Barranquilla, located in the city of the same name. The scavengers had been killed, their organs recovered and sold for transplants. Their bodies were sold to the University for Dissection by medical students. It is estimated that two thousand individuals had been killed by the end of 1994 as a result of the "social cleansing" campaign in Colombia (Anon, 1994a; Semana 1992)

The impact of not integrating the informal sector is far reaching;

-The burning and dumping of non-economic materials leads to environmental hazards

-Most junkshops are eyesores thus bad aesthetics

-Trading in stolen goods leads to lack of peace and order

-Increase poverty and marginalization

[13] Oepen, M. Scavengers and recycling in Indonesia, *GATE* No.1, 1993.

Figure 2.4 Scavenging in Buea

Traditionally, community has been acting the role of a recipient of waste disposal service

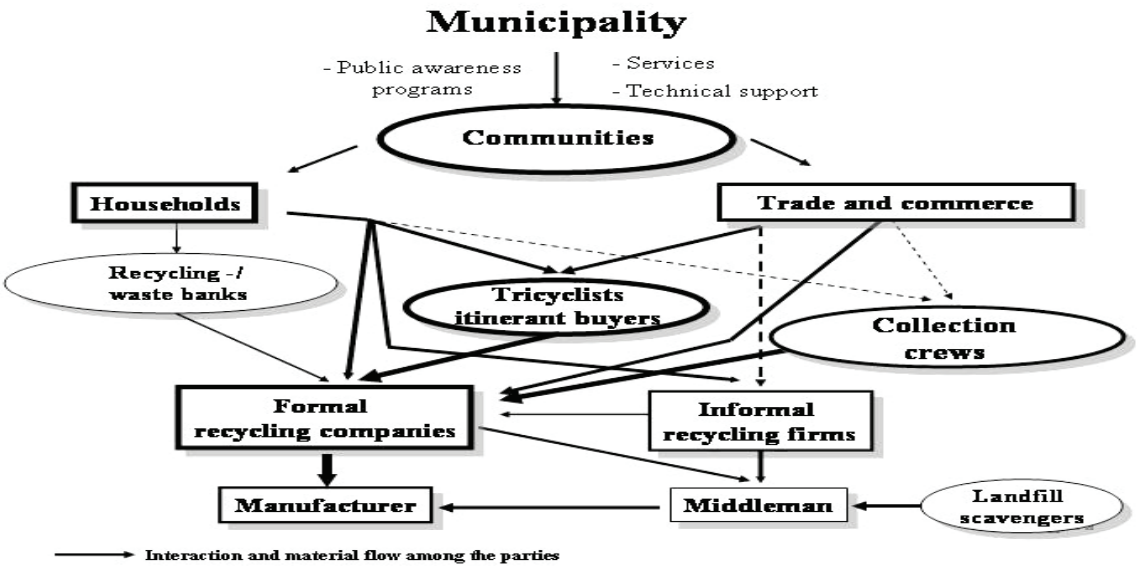


Figure 2.4 Interaction and material flow within the community[14] **(Source:** Suchada, P. et al. 2003).

[14] The informal sector plays a major role in recycling system of municipalities in developing countries; consequently, the Municipality should support them in both technical and financial aspects, as well as retains the responsibility for enforcing environmental standards and supervising the sectors.

Despite the health and social problems associated with the informal sector, it provides significant economic benefits that need to be retained. Integrating the informal sector into waste management planning, building on their practices and experience, while working to improve efficiency, living and working conditions of those involved is the most preferable option **(**Wilson, C. et al. 2006**)**

Resource recovery from waste stream is desirable because it cuts down on the cost of transporting and disposing of municipal waste. Money generated from the scale of recovered resources can offset collection costs. In many developing communities, there is a formal system for waste collection, a network highly developed for resource recovery. This network may consist of door-to-door collectors and/or "scavengers" who separate re-usable materials at dumps and collection sites. According to Ohnesorgen (1993), scavengers are, in a sense, a resource, because they recycle solid waste, and cities have to learn to work with them and train them, not work against them.

2.3.1 Case Study I: Cairo – Egypt

According to Jensen (1991), an attempt in Cairo-Egypt to introduce first-world municipal collection failed: trucks broke down, compactors failed, the streets were too narrow, and the system was too expensive. The municipal authorities then began to work with private waste collection contractors and with the Zabballeen, the municipal scavengers who traditionally collected reusable wastes from dump sites. This approach enabled the city to introduce some mechanization and to improve solid waste collection services while maintaining the Zabballeen's livelihood and the flow of recyclables (paper, metal glass, bone etc to small workshops throughout the city.

2.3.2 Case Study II: Harare – Zimbabwe

According to Kneeling 1991, the extensive recycling industry in Harare, Zimbabwe is a system that is being supported by collectors who pick up scraps from industries and scavengers who sort waste from tip sites and sell materials to contractors' representatives at the site. The secret of continuity of this system is the co-operation between the contractors and the municipality, which allowed scavengers to operate at city dump sites.

2.3.3 Case Study III: Curitiba - Brazil

When the city of Curitiba, Brazil was faced with a serious waste management problem, it did not do what other cities might have done. Getting a loan and then buy an expensive recycling plant is a conventional solution for such dilemmas. Curitiba decided to get its citizens involved by mounting a campaign in schools and neighborhoods to encourage households to separate the waste (organic waste which can be turned into compost, on one side and non-organic recyclable, garbage on another).With the aid of fleet of brightly-painted vans (left), "garbage that is not garbage" was collected from all neighborhoods. In collaboration with the organization called Institute for Social Integration, the city hired large numbers of previous unemployed people to separate the recyclable materials---paper, metal, plastic and glass – a job which $70 million recycling plant would have done at far greater cost, employing far fewer people.

Benefits of this project:

- The city of Curitiba saved millions of dollars
- Hundreds of unemployed people became productive, salaried workers.
- The business community benefitted by providing the vans that collected the recyclable materials.
- Everyone pitched in and everyone gained**.**

According to Rabinovitch (1992), the success of the source separation program "Garbage that is not garbage" in which 70% of the community participates, has been attributed to community education.

Based on Habitat 1990 report, there are five changes in attitude among professionals in solid waste management in developing urban areas:

- Local solutions are needed to match local needs;
- Different kinds of vehicles are appropriate in different situations;
- The recognition that district or neighborhood-level garbage collection schemes devised and managed in cooperation with the residents are often the cheapest and most effective solution
- Scavengers can be made an important component within garbage management systems but they need a supportive frame – perhaps most especially in the provision of service to address their health problems.

- There are complementaries between garbage collection and other improvements in infrastructure and services.

Locally designed and contractor-operated systems seem to be the most successful, appropriate incentives and overall direction must be sustained by the authorities(Ohnesorgen 1993).Co-ordination and co-operation are required when involving scavengers in an integrated solid waste management program. But such co-orporation is challenging in developing countries which have week governmental structures thus the need for the development of effective institutions for collection system.

2.4 Top down approach to waste management

Getting the right resources to where they are needed most and ensuring those resources are being integrated in a sustainable manner is the most critical issue with international development. A lack of comprehensive knowledge of the realities on the ground leads to wasting of resources thus, the greatest failure of international development to this day (FSD, 2010). It is worth noting that while a lot of money is being allocated to develop country projects, there is shockingly little growth to show for it. This can occur when bureaucratic interventions by governments, foreign agencies or transnational conglomerates impose **"top down"** solutions and fail to take into account both needs and wishes of the bottom. Thus success and sustainability are much likely if solutions to community issues are identified and rectified by community development remedies (Howes, 2009).

Grassroot development is seen by many as a means by which underserved communities can have a voice, invested interest, and ownership in the development of their land, economy, education, rights, and values. Cultivating a thorough understanding of the complex realities on the ground is the key to empowerment and collective action (FSD, 2010).

Various measures are being implemented to improve on refuse collection, upgrade disposal facilities and lessen the risks to human health and environment associated to waste management. According to Medina (2002), to solve MSW problems in cities in developing countries solutions often proposed have the following features;

- **Centralized and undiversified** – solutions that are unable to distinguish the needs and heterogeneity of neighborhoods with each city, and between cities.

- **Bureaucratic** – top-down solutions, usually reached without or with little community participation
- **Capital-intensive approaches**- involving advanced technology and equipment, frequently imported from developed countries
- **Formal** – conventional solutions only consider the formal sector, neglecting the existence and possible contributions of the informal sector that has developed around waste collection and recycling in developing countries.

It is worth noting that conventional solutions do not take into consideration the following aspects: consumption patterns, income, standard of living, institutional capacities and capital availability for urban investments

Overall cost and functionality are the primary reasons for the success of a given process at the local level. Widespread failures have been as a result of financial commitment and effort required to maintain equipment sufficiently to keep a large scale operation running. In India, 9 of 11 plants were closed, in Brazil only 18 of 54 facilities operating in 1990, and elsewhere (Hoornweg, et al. 1996) .According to Hoornweg, et al (1999), UNEP (1996), these failures have been attributed to the following;

- Failure to understand and maintain biological conditions required
- Failure to properly understand market conditions and correctly predict demand for finished product
- Poor pre-sorting of incoming waste to remove non-compostable materials resulting in poor finished product
- An over-emphasis on high-cost mechanization as opposed to manual labor
- Overall higher economic costs than those associated with landfilling same quantity of waste.

2.4.1 Top-Down Scenarios

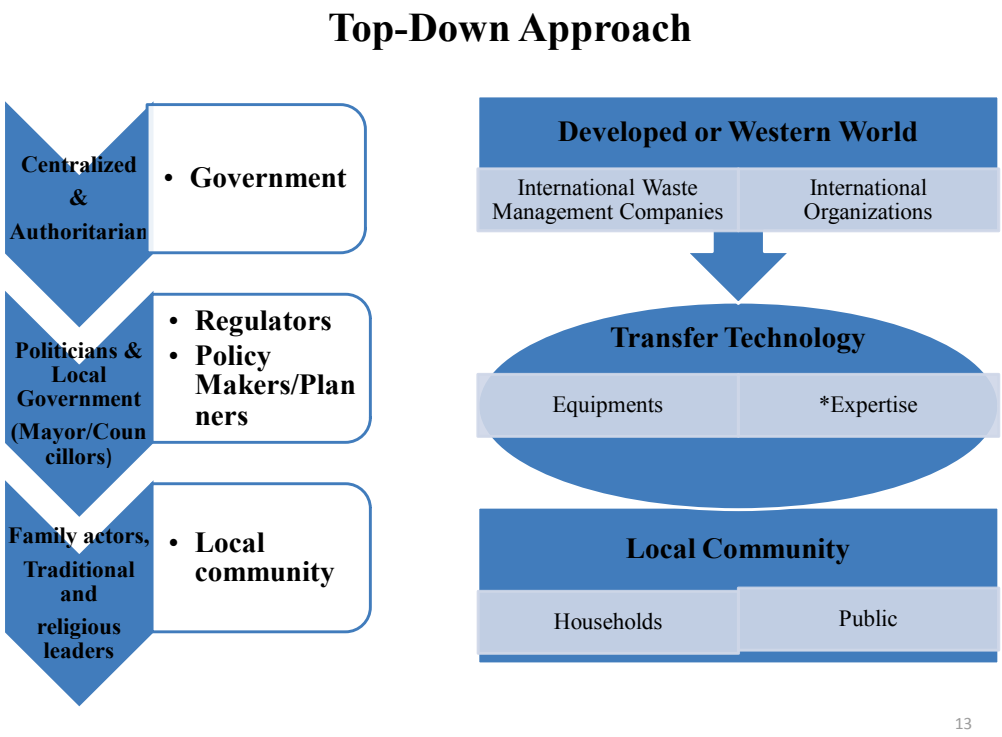


Figure 2.6: Top-Down approaches in terms of policies and technology transfer (*Not always the case).

Foreign investments in developing countries have multiple benefits like job creation. However, investments made by waste management companies in developing communities mean the transfer of technology and methods that function well in the developed world. This transfer of technology is not desirable in many cases due to different physical and socio-economic conditions prevalent in developing and developed countries. Compact trucks for instance were designed to handle low density waste but refuse in developing countries have high organic content and high density. To this effect, waste generated by most developing residents is very dense and needs not to be compacted.

2.4.2 Case Study I: Belize City[15] – Mile 27 plan

Large Development Projects are Push forward „from the top down without taking locals into Consideration.

According to Allen Hershkowitz (2001) of the Natural Resource Defense Council, a nation such as Belize, which markets itself as an international ecotourism destination with deep concern for the environment could make major decisions without proper regard for environmental consequences.

Based on the government, mismanagement of waste was the number one environmental problem in the country. Simultaneously, it approved a new disposal site, named Mile 27 landfill, to replace its open dump outside Belize City. Mile 27 plan was filled with environmental problems.

-The landfill was to be in an abandoned quarry site adjacent to the Sibun River. The landfill was designed without impermeable barriers to control leachates, despite the fact that the rock lining the quarry was mostly limestone, karst, and marl. With all such porous materials, rocks would readily conduct leachate into the surrounding soil and ultimately into the river. Yet the environmental statement prepared by the Canadian developer provided for no regulation of landfill gases or leachate management, despite the fact that downstream of the dumpsite 12 villages use the river for drinking water and subsistence fishing.

The Belize government attempted to push the project ahead and funding was secured from the Inter-American Development Bank (IADB). Only after one and half years of pressure on the government and IADB from environmental NGOs and through citizen protests, was the project moved to a less controversial and environmentally more appropriate site.

[15] Hershkowitz, Allen. (2001). Dumping on paradise. Amicus Journal 23, no. 1, Spring 2001

2.4.3 Case Study II:

A - Zero-Waste –Experiment[16]: Kamikatsu-Japan

A small town located in one of the most remote and mountainous regions of Japan aim to tackle its problem of waste through an extensive system of waste management. The scheme was adopted when councilors realized it was much cheaper than incineration – even if the incineration was used to generate power.

The root of the program focused on the responsibility for garbage collection down to the individual household. There are no trash pickups and each household creates and manages its own organic compost bin. For metals, plastics, industrial oil and other non-compostable materials, residents must carry their own waste to a garbage center, where it is sorted into one of the 34 individual disposal categories.

A poll showed that although the zero waste policy had many people in favour, 40% of people were not happy about all aspects of the scheme. The Mayor of Kasamatsu was undeterred:" we should consider what is right and what is wrong, and believe it is wrong to send a truck to collect the waste and burn it"

Although this massive project has witness great success, it is worth noting that large towns and cities in places with more individualistic and freewheeling social norms would be hard pressed to enforce such an aggressive plan without ending up with a full-scale revolt. Just the logistics of coordinating collection centers so that the entire population of a full-sized American city could drop off and separate their garbage each day, one car at a time, are daunting.

Source: Catalano, C. 2008

[16] The Zero-Waste Experiment of a Small Japanese Town .2012

B- Siting Hazardous Waste Management Facilities

Siting hazardous is an extremely complex and difficult endeavors. The Public aversion to the construction of these facilities in or near their community often results in concerted opposition, referred to as the NIMBY syndrome[17]. For the most part, siting processes do not fail because of inadequate environmental or technical consideration, but because of adversarial decision-making strategies employed by the proponents. Siting has evolved from approaches dominated by top-down decision making to increasing decentralized and pluralistic approaches (Richard G.k et al.1998)[18]

2.4.4 Case Study III: NIMBY syndrome 1- British Columbia

A review of **British Columbia's** 1987 siting attempt reveals that the government and proponent were not truly committed to an open approach. Although communities initially volunteered to be in the process, the province and a private consortium failed to follow through on maintaining trust and power sharing. The province failed because it became involved in a program attempting to convince communities to accept a facility. Residents subsequently came to believe the siting approach was, in essence, a public relations game. As a result, well-organized community opposition organizations formed and prevented the siting attempt.

While the siting approach failed, it was successful at not becoming a cost burden. The siting attempt lasted less than two years and cost approximately $Can.750, 000, excluding the site exploration costs. It became clear that the facility would not be sited early in the process, and the expense of detailed environmental investigation was avoided. Moreover, the community did not become embroiled in a protracted conflict over a project that may be beneficial to the government's reputation in any future siting attempts.

[17] Antipathy to, or hatred of location of so-called annoying facilities such as solid waste disposal sites and sewage treatment facilities in the neighborhood. It is reflecting the social trends of agreeing with the plan in general, but disagreeing with it on details, or the idea that it is required somewhere, but it is not welcome in my neighborhood.

2.4.5 Case Study IV[19]: NIMBY syndrome II: Ontario

In July 1981 the Government of Ontario created the Ontario Waste Management Corporation (OWMC) with a mandate to establish and operate a hazardous waste facility.

OWMC's siting process for an integrated hazardous waste treatment facility in West Lincoln in southern Ontario stands as a hallmark of siting failure. The siting process lasted 14 years and cost $Can.140 million (Vetsch 1989). The irony in Ontario siting failure was that the **rigourous top-down** approach was intended to find the best environmental site, yet the proposal failed to ensure environmental protection. The closed approach siting caused the OWMC many problems because it had to operate in a negative political climate. The environmental hearings that were held were full of conflict and protracted because communities saw them as their last attempt to prevent siting.

While OWMC was successful at negotiating a siting agreement, it appears the township was not a willing host and only signed the agreement to protect itself. Although an agreement had been made with the community, the Environmental Assessment Board rejected the project because it failed to adequately protect the environment.

Source: Vetsch, J. L. 1989

In Manila, of the 300 compact trucks donated by the Japanese government in 1990, only 120 operated in 1992.

Three incinerator built in Lagos-Nigeria in 1999 with Western European grant – at a cost of U.S. $ 30 million were never used and two of them were dismanantled in 1989 and the third converted into a civic center.

In 1991, an incinerator was built in Surabaya, Indonesia that doubled the MSWM budget for the city. As a result of the climate and high humidity of waste, refuse must be dried in the sun

[19] Approaches to siting toxic and hazardous waste facilities: A comparison of procedures adopted by Ontario and Alberta. *Environments* 20:60–69.

for five days, and even after that, it requires the addition of fuel in order to sustain combustion.

2.5 SOLID WASTE MANAGEMENT IN AFRICAN COUNTRIES

MSW management has become a major issue of concern for many under-developed nations as population increases. The problem is compounded following the rapid urbanization of many nations; 30-50% of population in many developing countries is urban (Thomas-Hope 1998) and in many African countries the growth rate of urban areas exceeds 4% (Senkoro, 2003). To keep pace with the problem of waste management is still a major challenge although many developing nations do spend between 20 and 40% of municipal revenues on waste management (Schübeler 1996, Barton 2000). As far as waste management is concerned, open dumping of solid waste is a way of life in most part of Africa. It is recently that researchers and waste managers started figuring out the contribution open dumps are making towards environmental degradation[20].

The governments of developing countries have given a low priority to the development of controls over solid waste generation and safe disposal. This is due to failure to understand the threat which inadequate management could pose to human health and the environment. In developing countries especially Africa, there is a general migration of population from the countryside to urban areas. As a result, waste management practices differ vastly between rural and urban areas and within the latter between suburban and peri-urban[21] areas (Muniafa and Otiato, 2008).

Solid waste management in most developing country cities account for 20% to 50% of available operational budgets for municipal services, yet only providing a service for 50% of the urban population and collecting only 60% to 70% of the refuse arisings (Bartone et al., 1991). This is a reflection of gross inefficiencies which are commonplace with management responsibilities entrusted to lowly paid officials who lack authority and sometimes management expertise. The World Health Organization asked African countries the

[20] Attraction of vectors and ground water contamination.

[21] (Peri-urban is defined as locations with 250-1000 person/km$^{2)}$.

opportunity to prioritize their environmental health concerns. The results revealed that while solid waste was identified as the second most important problem after water quality, less than 30% of urban populations have access to "proper and regular garbage removal"

Many developing countries have a common institutional issues which include the lack of legislative framework for integrated MSW management and resource constraints, underfunding of municipal councils, lack of integrated management system components and lack of effective educational programs to encourage source separation of organics and dry recyclables (Lopes et al., 2007) .The World Bank (2006) is aiming at annual economic growth rates of 7% up to 2015 as well as an increase in infrastructure investments from 4.7% to 9% of GDP, in order to alleviate poverty.

Studies carried out on solid waste incineration for large cities in Kenya, Malawi and Zimbabwe (DFID, 1999) found that 75-80% of municipal solid waste was organic while in India, 70% was organic (Yedla and Parikh, 2002).

Table 2.10 Internal waste composition database on African projects.

	Kenya (Urban)	Uganda (Kampala)	Namibia (Windhoek)	Nigeria (Lagos)	Egypt	Mozambique (Urban)	Cameroon(Douala)
Food waste	51.5	73.8	36	60	60	67	65.79
Paper	17.3	5.4	20	14	10	13	9.86
Textile	2.7	-	-	-	2	-	4.26
Plastic	11.8	1.6	16	-	12	4	8.34
Grass/wood	6.7	8	-	-	-	-	0.82
Leather	0.9	-	-	-	-	-	-
Rubber	1.5		-	-	-	-	0.59
Glass	2.3	0.9	13	3	3	4	1.13
Metal	2.6	3.1	5	4	2	2	1.26

Other	2.7	7.2	10	19	11	4	
Total	100	100	100	100	100	100	100

Source: SLR Consulting Ltd. (UK)[22]

From statistics, it is worth noting that

- Per capita waste generation rates increase as incomes rise and economic development occurs.

- The percentage of organic matter in urban waste streams of developing countries is relatively high with observable decline as economic development occurs.

According to UNEP (2005), the rate of waste generation generally increases in direct proportion to that of a nation's advance in development and failure to provide a management system could result in greater environmental degradation with increase health risk to the urban population.

Solid waste management problems in developing countries are different from those found fully developed countries. This can be justified by the fact that the very composition of their waste is different from those of developed countries and solid waste rates average only 0.4 to 0.6 kg/person/day, as opposed to 0.7 to 1.8 kg/person/day in fully industrialized nations (Cointeau 1982; Blight and Mbande 1996).

[22] Unpublished internal waste composition database on African projects. Kemajou, A. et al., 2007

Chapter 3: Vital Concepts in Solid Waste management

3.1 Solid waste definitions

The term solid waste may be used to refer to municipal waste and falls under seven categories: residential (household or domestic waste), commercial, institutional, street sweeping, construction and demolition, sanitation and industrial wastes (Rush B, 1999). Likewise, municipal solid waste refers to solid wastes from houses, streets and public places, shops, offices, and hospitals, which are very often the responsibility of municipal or other governmental authorities. Solid waste from industrial processes is generally not considered as municipal. However, because this waste finally ends up in the municipal waste stream, it should be taken into account when dealing with solid waste. Synonymous to solid waste are terms such as “garbage”, “trash”, “refuse” and “rubbish” (Zurbrugg, 2000) especially in some literature in North America.

There is still no single scientific definition of solid waste. The notion of solid waste was not used in its current meaning until the twentieth century (Savas, 1977).

According to Pongracz (2002), the notion of waste is relative in two main respects.

- When something loses its primary function to a given user, it becomes waste. Therefore, one person’s waste output is often someone else’s raw material input.
- The notion of waste is relative to the technological state of the art and to the location of its generation.

The concept of waste therefore is a very dynamic concept and the notion has to be understood within this context. The EU, OECD, UNEP and other international organizations have their own approach to, and definitions of the notion of waste. (Louiguer, D.2007). Waste is defined according to the German legislation as portable objects that have been abandoned by the owner. This legislation has identified different types of waste.

Table 3.1 Definition of waste relating to their types

Waste Type	Definition
Construction debris	Detritus minerals from construction and demolition
Organic waste	Biodegradable component of municipal waste (e.g. food and yard waste)
Household	Waste from private households
Household-commercial waste	Waste from commercial establishments, businesses, the service sector, public institutions, and industries that possess similar characteristics than household waste
Commercial Waste	Waste with characteristics similar to household waste.
Municipal solid waste(MSW)	Household, bulky, household-like commercial, yard, open market, and construction and demolition waste; street sweepings; etc.

Source: German Technical Guidance for MSWM

According to Pfeffer (1992), solid waste is defined as "any solid material in the material flow pattern that is rejected by society. On this note, waste is a material that no longer has a value for the first user and is therefore thrown away. Considering waste as unwanted material can also be an issue of timing, that is waste can have some value for the person or society in different circumstances (Louiguer-). Other authors (Peavy et al., 1988; Tchobanoglous et al., 1977) define solid waste as all the waste arisising from human and animal activities that are normally solid and that are discarded as useless or unwanted. It is all –inclusive and encompasses the heterogeneous mass of throwaways from residences and commercial activities as well as the more heterogeneous accumulations of a single agricultural or industrial activity.

Types of Solid waste:

Solid wastes are usually one of three types, namely: municipal wastes, industrial wastes and hazardous wastes.

Municipal waste

The definitions of terms and the classifications used to describe the components of solid wastes vary greatly in practice as well as in the literature. The definitions presented in (Table 3.1) are intended to serve as guide for municipal solid wastes.

Industrial wastes

Industrial wastes are waste arising from industrial activities. They include rubbish (associated with the support personnel), process wastes, ashes, demolition and construction wastes, special wastes and hazardous wastes.

Hazardous wastes

Hazardous waste are classified as wastes that pose a substantial danger, either immediately or over a period of time, to human, plant or animal life. A waste is classified hazardous based on the fact that it exhibits any of the following characteristics: ignitability, corrosivity, reactivity or toxicity.

3.2 Integrated sustainable solid waste management (ISSWM)

From early beginnings, waste treatment and disposal was merely dumping and has developed to a more sophisticated range of options including re-use, recycling incineration with energy recovery and alternative technologies including pyrolysis, gasification, composting and anaerobic digestion.

This concept provides a systematic analysis of all issues relating to sound waste management which include: technical, socio-economic, financial, managerial capacities of city councils, environmental, political aspects and socio-cultural context. According to Klunder et. al. (2001)[23], ISSWM concept takes as a point of departure four basic principles:

[23] Klunder, A./ Anschütz, J./ Scheinberg, A. (eds.), Concept of ISWM, Gounda:WASTE, 2001, p.11.

- Equity: all citizens are entitled to an appropriate waste management system for environmental health reasons.
- Effectiveness: the waste management model applied will lead to the safe removal of all waste.
- Efficiency: the management of all waste is done by maximizing the benefits, minimizing the cost and optimizing the use of resources, taking into account equity, effectiveness and sustainability.
- Sustainability: the waste management system is appropriate to the local conditions and feasible from a technical, environmental, social, economic, financial, institutional and political perspective. i.e. it can maintain itself over time without exhausting the resources upon which it depends.

Table 3.2 Assessing the degree of integrated sustainability

Indicators	**Degree of Integrated sustainability**
Technical	Amount of waste collected by area of the city and per source
Environmental	Amount and percentage of waste recycled extent of pollution of air, soil and water
Financial	Degree of cost recovery, overall cost of waste management services provided, socio-economic: service coverage(% of citizens receiving minimum required waste collection service), user satisfaction with the service by area of the city
Institutional	Degree of formalization of informal sector

Source: Klunder and Anschütz, (1999) [24]

[24] Klunder, A./ Anschütz, J., Design of Sustainable System, CEDARE/IETC Alexandra/Egypt, 1999, p. 10

Key principles of ISSWM include: hierarchy principle, polluter pays principle, effectiveness and efficiency.

Integrated waste management has been defined as the integration of waste streams, collection and treatment methods, environmental benefit, economic optimization and societal acceptability into a practical system for any region (Warmer Bulletin 49, 1996). IWM is also concerned with the use of a range of different treatment and disposal options, including waste reduction at source, re-use of products and recycling of materials, recovery of energy, landfill, incineration, and alternative options such as pyrolysis, gasification, composting and anaerobic digestion. IWM evolved from the realization that one activity (e.g. recycling or recovery of products) alone would not achieve the objective of minimizing risks associated with waste. Thus the combination of activities is selected in a manner suitable to handle targeted portions of waste stream.

An IWM may also be interpreted as integration in terms of the management of wastes from **different sources** such as commercial, household and industrial, or else in terms of **different materials**, such as metals, paper and putrescible wastes, or of waste from **different product areas**, such as packaging waste, white goods etc. (Warmer Bulletin 49, 1996)

IWM, the term given to this overall concept, regards the following set of elements as comprising a hierarchy of choices: Reducing the quantity and toxicity of waste, reusing materials, Recycling, composting, incineration with energy recovery, landfilling, Incineration without energy recovery (Charles R. Rhyner et al.1995)

According to Lardinois and Furedy (1999), the waste management hierarchy is as follows:

- Avoid the generation of SW
- Reduce the negative impacts of the waste that is generated
- Reuse the materials recovered from the waste stream
- Recycle, compost, or recover materials to new products
- Recover energy by incineration, anaerobic digestion or similar processes
- Dispose of waste in sanitary landfills

According to EPA's integrated waste management hierarchy, four components are considered in order of preferences:

- Source reduction (or waste prevention), including reuse of products and on-site (or backyard) composting of yard trimmings.
- Recycling, including off-site(or community) composting
- Combustion with energy recovery
- Disposal through landfilling.

3.2.1 Case Study- Samoa[25]: Why consider integrated solid waste management?

In December 2005, Samoa, with the assistance of JICA completed the transformation of the Tafaigata dumpsite into a semi-aerobic landfill utilizing the Fukuoka method. The project was implemented at a cost of US$400,000 with a total projected lifetime of 10 years. However, a few years into the operation of the landfill, it was evident that landfill was filling faster than expected.

The reason for the increase in waste generation might include changes in lifestyles that led to the use of more disposable products, or improvements in the collection service and better awareness of the public, which meant that more people used the service and therefore more waste was collected.

It was clear that focusing on waste disposal alone by improving the landfill, only solved a part of the problem, and as a result the landfill will require expansion far sooner than was originally planned. The focus has now expanded to include measures that address waste minimization and reduction at source in order to reduce residual waste entering the Tafaigata landfill.

[25] Pacific Regional Solid Waste Management Strategy 2010-2015. – Apia, Samoa: SPREP, 2010. vi, 42 p. ; 29 cm---- http://www.sprep.org/att/publication/000819_PacificRSWMS2010_2015.pdf , accessed Feb.2012

3.2.2 Case Study: An investigation into Mexico[26] City's failure to recycle

In Mexico City, everything (whether in homes, on the streets, in cafes) goes in the same trash bin and meets the same fate; landfill. The cause for concern is; why produce so much unnecessary waste and why the hesitant to change an outdated system?

The 2003 law passed by the Mexico City requiring residents to sort their trash. Why did nothing come out of this?

- The City never installed the infrastructure to support this law
- Waste processing plants not having the facilities to effectively sort garbage while 90% of garbage trucks not designed for the separation of organic and inorganic waste.
- No culture of recycling in the City and as a result, only about 6% of waste is recycled in the City while must recycling is done by the informal economy despite emergence of a few recycling companies and nonprofit organizations.

Closure of the City's only landfill and second largest in the world breaths fear that the 12,600 tons of garbage deposited daily which has amounted to 76 million tons of trash will fracture Bordo Poniente's base and leak contaminants into the soil and aquifer.

Source: Whitney, H. (2010)

According to UNEP (1996) a laid out series of questions is imperative to be asked when evaluating technologies and policies in the context of an integrated MSW system:

[26] http://bypides.wordpress.com/2010/11/27/an-investigation-into-mexico-city%E2%80%99s-failure-to-recycle/ 21.05.12

- Is the proposed technology likely to accomplish its goals given the financial and human resources available?
- What option is the most cost-effective in financial terms?
- What are the environmental cost and benefits?
- Is the project feasible given administrative capabilities?
- Is the practice appropriate in the current social and cultural environment?
- What sectors of society are likely to be impacted and in what way; are these impacts consistent with the overall societal goals?

3.3 Resource Recovery

When waste is disposed of, it does not vanish but ends up somewhere else or in some other form. Its value as a resource is retained when it is used or put in the right place. Wastes generated in a community can be a valuable energy and material resource. Waste being a resource as well as a burden has generated some extremely creative and economically attractive waste-to-energy systems to utilize wastes while mitigating their environmental impact (Isaacson, 1991). Waste management is a common concern of all communities because all communities produce waste. Thus, it is possible to utilize many of these wastes to make real profit in terms of the environment, economics, energy supply and conservation and material recovery.

Recovery of waste into pure raw materials and organic materials is import. According to Mathew, V (2005), two aspects of recovery can be considered:

Front end recovery- which involves mechanical extraction of usable elements, results in new raw materials,

Back end – which consist of composting or burning organic material in order to recover usable material or energy.

Resource recovery is the conversion of solid waste into saleable energy. Garbage and other refuse is burned to produce either steam or electricity. A facility constructed to perform this function is used in two methods. Mass-burn incinerates almost totally unprocessed refuse. The refuse derived fuel (RDF) technique shreds and compacts the refuse to achieve greater energy

intensity. It is generally estimated that one ton of garbage contains slightly more energy (in BTUs) than a barrel of oil.

Based on the amounts of different forms of energy and materials that might be recovered from the waste available, it facilitates the identification of markets. Also, the amount and form of energy available in the study area largely depends on the characteristics of the waste and the particular type and size of energy conversion technology utilized (William Robinson). The quantity and quality of the waste a resource recovery facility receives will determine its success or failure. The availability of this waste depends on the existing population and the rate of growth.

In communities where the forces favouring resource recovery are nearly balanced with those forces acting in opposition, timely community education programs may have some impart. There are some factors that generally contribute to the practice of material recovery in developing countries. Based on Diaz et al. (2007) report, the following contributions are relevant;

(a) Material and energy conservation – limitation of less costly virgin materials which are valuable to local industries, lack of affordability or production capacity for items that can be remedied by recovery of useable materials from wastes, and shortage or relatively high cost of energy.

(b) Economic conditions – a relatively undeveloped or developing economy of the country.

(c) Soil conservation – soils that are of low quality or that are being rapidly depleted of organic matter. This can be remediated by establishing community based contractors to scavenge and recycle waste. The only limitation of such measures may be inadequate financial support for staff recruitment, purchase of equipment, operational procedures and improving living conditions(Liebenberg, 2007)

3.4 Clean Technology for sustainable development

Technology is at the core of global environmental challenges; as a source of environmental degradation and emissions, as a means to address negative impacts, reduce emissions, manage natural resources and monitor conditions, as a foundation for economic development, value creation, and employment[27].

Various UN conventions support the need for clean technology for sustainable development:

- Stockholm Convention: it aims to promote the use of best available techniques and environmental practices to reduce persistent organic pollutant (POPs) releases from unintentional production which includes: waste incinerators, aluminum production, open waste burning etc.
- UN Framework Convention for Climate Change (UNFCCC): Agreement on the technology Mechanism in December 2010 to support action on technology development and transfer for mitigation and adaptation.
- Montreal Protocol: Adopted decision on environmentally sound destruction of ozone depleting substances (ODS) banks. The Multilateral Fund is request to continue its efforts on further cost-effective projects for the destruction of ODS banks, using appropriate technologies.
- Convention on Biological Diversity (CBD): It recognizes that access to and transfer of technologies among Parties is essential to achieving CBD objectives.
- According to IPCC (2001)[28] technology transfer is defined as "a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders."

This definition involves the following aspects:

- Encompasses diffusion of technologies and technology cooperation across and within countries;
- Covers technology transfer processes between developed countries, developing countries, and countries with economies in transition;

[27] GEF & Technology Transfer (2001). An overview- Expanded Constituency Workshop, Hotel Memling, Kinshasa, DR Congo. http://www.thegef.org/gef/TT accessed 14.02.12

[28] *Metz et al. for IPCC, 2001)*

- Comprises the process of learning to understand, utilize and replicate the technology, including the capacity to choose and adapt to local conditions and integrate it with indigenous technologies.

The definition of transfer technology goes beyond hardware, and encompasses capacity, know-how, policies and institutions.

3.4.1Transfer technology (T-square)

According to Schmitt, et al. (1985), there are many definitions of T-square as there are combinations and perturbations of:

- Technologies themselves,
- Creators of technologies (or donors)
- Recipients of technologies (receivers or users)
- Transfer methods,
- Facilitators of technology transfer (T-square providers or agents),

T-square is a process by which existing technology is transferred or transformed to fulfill the user's needs Robert Krull (OECD Seminar, 1990). A more complete definition was given in a National Cooperative Highway Research Program (NCHRP) Synthesis (Hodgkins, 1989). T-square defines as the process by which research and other new technologies are transferred into useful processes, products, and programs.

There are essentially three flows that make up the technology transfer process:

- Capital goods and equipment
- Skills and know-how for operating and maintaining equipment
- Knowledge and expertise for generating and managing technology change (Sub-theme

3.4.2 Barriers to transfer technology:

Lack of resources; poor infrastructure and utilities; inadequate/poorly implemented laws and regulations; shortage of trained technical and managerial personnel; weak local supporting industry; high cost of certain technology agreements and inappropriateness of technology transferred; overall political and macroeconomic instability in some countries(Andersen et al. 2007**)**

3.4.3 Technological options for treatment of MSW

With rapid urbanization and changing lifestyle that has increased waste load on the urban environment to alarming proportions, dealing with waste is a major challenge. According to Varma Ajayakumar R. (2008)[29], two aspects to the challenge can be identified: the social engineering and technology application.

-Social engineering deals with the ethics and efficiency for maintaining environment. With regards to waste management, it is the practice of reduce, reuse and recovery.

-The technological application deals with the improvement of assimilative capacity as well as supportive capacity of environment. A review of the waste management technology in general.

Presently, technology options available for processing of MSW are based on either **bio** conversion or **thermal** conversion (UNEP, 2005; Diaz et al., 2002). The bio – conversion process is applied to the organic component of waste, to form compost or to generate biogas such as methane (waste to energy) and residual sludge (manure). The thermal conversion technologies are incineration with or without heat recovery, pyrolysis and gasification, plasma pyrolysis and pelletization or production of Refuse Derived Fuel (RDF).

Thermal treatment involves conversion of waste into gaseous, liquid and solid conversion products. Three types of systems can be considered:

1) Combustion system (incinerators): Thermal processing with excess amounts of air.
2) Pyrolysis systems: Thermal processing in complete absence of oxygen (low temperature).
3) Gasification systems: Thermal processing with less amount of air(high temperature)

Pyrolysis is widely used in industrial processes but has been less successful as treatment option for MSW. Combustion systems have been used widely as thermal treatment process for MSW. The following three types of combustion systems have been used extensively for energy recovery in different countries:

- Mass-fired combustion systems (MASS)
- Refuse Derived Fuel (RDF)
- Fired combustion systems and fluidized Bed (FB).

[29] Technology options for the treatment of MSW

The municipal solid waste must possess a relatively high calorific value in order to be viable for energy recovery through thermal processing.

Biological Treatment involves the use of micro-organisms to decompose the biodegradable components of waste. Two main processes used are:

1) Aerobic processes: windrow composting, aerated static pile composting and in-vessel composting; vermin-culture etc. The utilizable product is compost. Aerobic composting is adapted worldwide.
2) Anaerobic processes: low solid (wet process) & high solid (dry process) anaerobic digestion. The utilizable product is methane gas(for energy recovery)

3.5 Public Participation (PP) & Corporate Social Responsibilities:

Public participation is a framework of policies, principles, and techniques which ensure that citizens and communities – individuals, and organizations – have the opportunity to be involved in a meaningful way in making decisions that will affect them, or in which they have an interest. The rationale of effective public participation is bases on the fact that everyone generates waste and can be affected directly and indirectly if waste is well not well management.

According Fatin, S. et al. (2011), community participation is important for the following reasons:

- It can effectively and efficiently target resources. This is because through public participation, community will be willing to share ideas and opinions.
- It can allow two-way communication and thus pave the way for participants to give new ideas. Through two-way communication, conflicts can be solved amicably and information delivered effectively.
- It offers a new thinking and innovative ideas from community. Through opportunity provided, community will have the pleasure to voice out their opinion. More so, it will train community to think creatively and become more innovative.
- By community involvement in planning and decision making, community will have the responsibility and sense of ownership. Making community feels involved in the project.

- It is a process of empowering people and it is a way to sustainable planning and development.[30]

Principle 10 of the Rio Declaration states: "Environmental issues are best handled with the participation of all concerned citizens, on a relevant level. On a national basis, each individual should have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States should facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy should be provided."

In a broader sense, pp is defined as the involvement of citizens in governmental decision-making processes. This includes being given notice to public hearings to being actively included in decisions that affect communities. PP is a means to engage stakeholders so that those most likely to be impacted by a particular activity can influence the outcome. It is a dialogue which enables the public to understand and influence decisions. According to EPA(2005), pp not only involve private citizens but institutions, civil society, labour unions, the government, public officials, industrial, agricultural and trade associations, scientific and professional societies, environmental, education and health associations and other minority groups.

Based on the fact that the public is not a monolithic entity, Mc. Garity (2005), recommends that relevant publics be identified to ensure that their rights are not compromised. A wide variety of models are given from which to choose and any chosen should reflect the public input required.

[30]http://www.internationalconference.com.my/proceeding/icm2011_proceeding/070_260_ICM2011_PG0962_0976_COMMUNITY_PARTICIPATION.pdf accessed 24.02.12

Table 3.3 Models Of Public Participation

Model	Description
Exclusionary Model	Indicates that the government or agency is the exclusive guardian of the people and any self-acclaimed representative of the public interest was an officious meddler i.e. Appointed or selected decision makers to make decisions for the populations who may not have the knowledge and information to make decision for themselves.
Confrontational Model	When a person feels excluded or that his/her interest has not been well represented, he can confront the agency. e.g shouting matches at meetings during debates on SW disposal sites or incinerators or other SWMP components being located near their homes and offices.(Confrontation, not conducive to informed dialogue about risks & mitigation)
Adversarial model	Represents a situation where all interest groups have a right to participate by submitting facts, evidence, views and arguments. The Agency assumes a neutral decision-maker.
Due Consideration model	Similar to Adversarial except that the agency takes a position prior to the public hearing and invites the public to comment on their decision as well as on the issues generally.
The mediation model	It requires that representatives of groups meet together, often with the aid of a mediator or facilitator, to present facts and

	arguments so as to reach an agreement on the ultimate result. Agency may participate in discussions and attempted to implement agreed solutions. Useful approach in planning SWMPs where relationship between government and residents is often confrontational.
Advisory Committee model	Similar to mediation except that it relies heavily on scientific and technological expertise. Agency appoints committee experts to advice on the technical issues and on a resolution. Model favours decision makers who are not scientifically trained.

Source: Mc. Garity, 2005

The practice of public participation is complex but it is process that will contribute to overall results of the business or enterprise.

According to Evans (2002), the success of public participation is measured on four core values:

Equity – decision makers should provide opportunity for all those with an interest in the subject.

Integrity – decision-makers must act in good faith

Openness – provision of information to the public that is accurate, honest, comprehensive, clear and accessible.

Accountability – Specifying the degree to which public involvement would influence decision making and accurate reports on how commitments are discharged.

Evans basically uses qualitative approaches and depends on processes in planning and decision-making which can only be implemented long after the beginning of the consultation process.

Table 3.4 IAP2 Public Participation Spectrum

INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
Goal: To provide the public with balanced and objective information to assist them to understand the problems, alternatives, opportunities and/or solution	**Goal** To obtain public feedback	**Goal** To work directly with the public to ensure that their concerns and aspirations are understood and considered	**Goal** To partner with the public in each aspects of the decision	**Goal** To place final decision-making in the hands of the public.
Promise: To keep public informed	**Promise** To keep public informed, listen to and acknowledge their concerns and provide feedback.	**Promise** To work with the public and provide feedback on how the public inputs influence the decision.	**Promise** To look to the public for advice and innovation in formulating solutions and incorporating such advice into decisions to the maximum extent possible.	**Promise** To implement what the public decide
Tools: -Fact sheets -Websites	**Tools** -Public comment	**Tools** -Workshops -Pollings	**Tools** -Citizens advisory Committees -Consensus	**Tools** -Citizens jury -Ballots

-Open houses	-Focus groups		building -Participatory decision-making	-Delegated decisions

Source: IAP 2005

3.6 Waste Characterization

Two basic approaches to estimate quantities of municipal solid waste at local, state, or national levels are identified as – material flow and site-specific.

3.6.1 Material flow

Mankind's needs (food, clothing, and shelter) are met by materials extracted from the earth. Materials are needed to maintain and improve our standard of living. People everywhere use material goods and discard solid waste on a daily basis. Understanding the whole system of material flow, from source to ultimate disposition, can help us better manage the use of natural resources and protect the environment. Material flow, in its most literal sense, is a systems approach to understanding what happens to materials we use from the time a material is extracted, through its processing and manufacturing, to its ultimate disposition (USGS, 1998). Materials flow through cities on a daily basis, entering as needed products and leaving as wastes.

Material flow methodology is used to quantify and characterize the material waste stream and it is based on the production data (by weight) for the materials and products in the waste stream. Adjustments made in order to estimate generation data are twofold: (i) for imports and exports and for diversions from MSW (e.g. building materials made of plastics). (ii) Adjustments for lifetimes of products. One problem with the material flow methodology is it does not account for product residues associated with other items in MSW.

The management of municipal solid waste provides both sanitation and recovery of valuable materials. In developed countries in the past, and in developing countries today, the relationship between urban wages and material prices promote recovery of many materials. However, as wages rise, people become less willing to engage in labour intensive recycling.

Simultaneously, the waste stream expands and changes in composition. At high income levels paper represents a greater fraction of urban waste. African, Asians and countries developing in the twenty-first century need to manage a changing and growing waste stream and plan for new approaches to recycling in order to make their development sustainable(Ackerman, F. 2005)

We can view waste management from two distinct perspectives: either in terms of sanitation or of material recovery**.** The opportunities to promote sustainable material flows and the problems of waste management depend on the level of development. The characteristic pattern of waste and the corresponding waste management system is a reflection of the income level of the city. Thus as income rises, the municipal waste stream expands and the composition also changes.

Table 3.5 Waste Composition of low-, middle-, and high-income countries, 1995

Percentage of waste stream consisting of:	**Country income level (%)**		
	Low-income	Middle-income	High-income
Organics(e.g., food waste) and other(e.g., ash)	88	69	40
Paper and paperboard	5	15	36
Metals, glass, and plastics	7	16	24
Total	100	100	100

Source: Hoornweg and Thomas 1999

A persistent low income pattern would suggest the development of composting programs for food waste as top priority. In countries like China where ash is an important part of the waste stream, plans for ash disposal is appropriate. As incomes rise from Mexican to American

levels, materials like aluminum cans are suddenly left in the streets uncollected, as the can collectors find better paying jobs. Thus a new, planned approach is needed, simultaneously as the composition of the waste.

Many metal objects such as scrap yards, discarded automobiles, building materials are recovered by market-driven recycling processes. It is worth noting that these wastes are often excluded from the waste stream composition figures mentioned above. Paper continuous to be a growth industry in high income areas.

Table 3.6 Global Paper Consumption Rates (1995)

Country	USA	Japan	Hong Kong	Germany	UK	Australia	South Korea	Ghana
Per Capita Paper Consumption[1] (Kg/year)	313	225	220	190	170	152	128	1
Per capita GNP[2](1995 US $)	26,980	39,640	22,990	27,510	18,700	18,720	9,700	390

Source: [31]Djuweng, 1997 & [32]World Bank, 1997b

Small appliances, cans and other household objects found in waste stream are worth recycling, but they are not the top priority for material recovery from urban wastes

Solid waste streams are basically characterized by their sources, the types of wastes produced, as well as generation rates and composition. Accurate information in these three areas is vital as it enables the monitoring and controlling of existing waste management systems and

[31] Djuweng, S., 1997. Timber Estates Threaten Forests. The Jakarta Post, October 10
[32] World Bank, 1997b. World Development Report 1997: The State in a Changing World. Washington, D.C., USA http://web.mit.edu/urbanupgrading/urbanenvironment/resources/references/pdfs/WhatAWasteAsia.pdf Accessed 28.02.12

enhances financial, institutional and regulatory decisions. In order to design and operate appropriate solid waste management systems, knowledge of the source and type of waste in a given area is prerequisite. Solid waste generators can be classified into 8 major categories: residential, commercial, institutional, construction and demolition, municipal services, processes and agricultural. However, based on waste studies, it varies greatly and some sources are completely excluded such as construction and demolition, industrial and municipal services.

Three key factors that affect waste generation rates include: **climate**, **socioeconomic** development and **degree of industrialization**. Likewise, external factors like geographical location, population' standard of living, energy source and weather.

3.6.2 Site-specific

Site-specific involves sampling, sorting and weighing the individual components of the waste stream that could be used. This methodology is used to define a local waste stream, especially if large number of samples is taken over several seasons. Added to this advantage, quantities of MSW components such as food scraps and yard trimmings can only be estimated through sampling and weighing studies. The disadvantage of sampling studies based on limited number of samples is that they can be misleading e.g. delivery of unusual wastes during the sampling period or an unusual wet or dry season. (EPA, 2010)

3.6.3 Solid Waste Management Systems

An effective solid waste management system is one that ensures better human health and safety. It must safeguard public health by preventing the spread of diseases and provide better working conditions. Thus environmental and economic sustainability should be a prerequisite of such a systems.

Environmental sustainability: It must reduce to the barest minimum, the environmental impacts of waste management.

Economic sustainability: It must operate at a cost acceptable to the community. Also, an economic and environmentally sustainable solid waste management system is effective if it

follows an integrated approach i.e. dealing with all types of solid waste materials and all sources of solid waste.

One or more of the following options are ideals of an effective waste management system:

1) Waste collection and transportation.
2) Resource recovery through sorting and recycling
3) Resource recovery through waste processing (recovery of materials such as compost) or recovery of energy through biological, thermal or other processes.
4) Waste transformation – without recovery of resources. Involves the reduction of volume, toxicity or other physical/chemical properties of waste to make it suitable for final disposal.
5) Disposal on land. This implies environmentally safe and sustainable disposal in landfills.

3.6.4 Functional Elements of SWM System

The activities associated with management of MSW from the point of generation to final disposal are grouped into the following functional elements: (i)waste generation; (ii)waste handling and sorting, storage, and processing at the source; (iii) collection; (iv) sorting, processing and transformation; (v) transfer and transport; and (vi) disposal. Functional elements are closely interconnected but they are not necessarily presented in every municipal solid waste management system. In most low and middle income countries, the system is limited to waste generation, handling at the source, collection and disposal at landfills. In most developed countries, every functional element is found within the system.

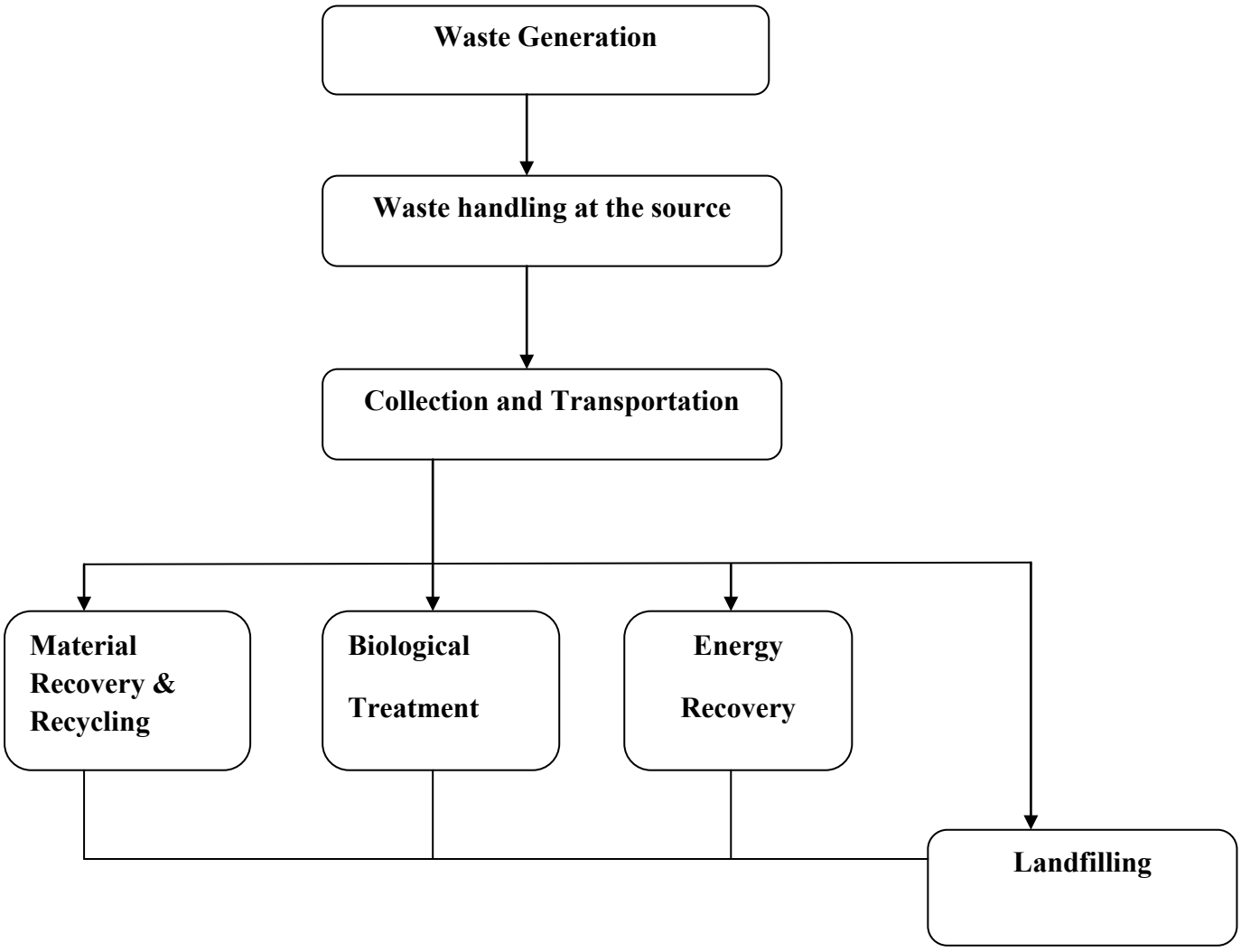


Figure 3.1 Functional elements of solid waste management (based on Seifert 2006a)

A typical waste management system includes the following aspects:

Household waste generation and storage

Reuse and recycling at the level of household (Animal feed and composting inclusive)

Primary waste collection and transportation to communal bin (transfer station)

Secondary collection and transport to the waste disposal site.

Collection includes not only the gathering of solid wastes and recyclable materials, but also the transport of these materials after collection, to the location where the collection vehicle is emptied. Location may be a material processing facility, a transfer station, or a landfill disposal site.

-Waste disposal in landfills.

Onsite storage is of primary importance because of public health concerns and aesthetic consideration.

Over the years, there has been a paradigm shift of SWM from being only a sanitary concern to including legal, institutional, technical, financial, environmental and socio-cultural aspects.

3.7 Policy Interventions for sustainability

Policy interventions for sustainable waste management are vital to support the technical approaches. According to Kurian, J. et al.(2007), some areas where policy intervention are necessary are in terms of people participation, capacity building, promotion and use of appropriate technologies and private sector participation.

Building administrative capacity for government and private sector players and technical capacity for designing, operating, maintaining and monitoring each part of the process is inevitable in order to operate an efficient, effective and environmental sound MSW programme. Training that builds human resources and institutional capacity at appropriate level is vital for NGOs, private sector companies and government entities. The creation of a national resource center will meet the need to improve professional training.

When there is the lack of political will, administrative, technical capacity or financial resources, major changes and plan of action are difficult to implement. In most cities in developing countries, itinerant collectors recover high value recyclable material at residences and small industries. This high level reuse of organic waste is a reflection of the extent of poverty by these waste pickers who indulge themselves in the recovery and reuse of materials with the lack of protective equipments. This exposes them to disease organisms, dangerous objects and other hazards in the waste. The standard of living of can be improved if waste collectors are organized and the collection services are stabilized. This entails firm policy and suitable method for introducing market-based instruments.

The introduction of specific revenue instruments like advanced disposal fee for non-recyclables and deposit refund system for recyclables in some cases will help to generate funds for MSWM. These policies must be exercised with social caution considering the fact that many people depend on waste collection and other related activities for their livelihood.

In order to implement economic instruments effectively, the following guidelines should be considered:

1) Definition of the basic goals and the context in which they are established.
2) Assessment of the environment in which they are carried out.
3) Simplicity and clarity in their functioning
4) Acceptation
5) Integration with existing sectorial policies.
6) Reduction of implementation costs
7) Assessment of economic and distributive effects.

According to Andres Flores-Montalvo (Mexico, 1995)[33], there is increasing implementation of economic instruments worldwide aim to encourage economic agents, whether producers or consumers, to adopt more environmentally sound attitudes. These instruments are an effective means of complementing or even substituting traditional command and control measures and have proven to be more efficient. International experiences show that economic instruments are successful in the task of protecting the environment. The Mexican case serves as an example to illustrate the process of introducing economic instruments into the environmental policy of developing country. Although slow but is proven to be fruitful. Such develop policies and programmes in this light are not an easy task. It requires ingenuity and integrated efforts among the different sectors of society.

[33] Mexico, 1995. Economic instruments in environmental management – The case of Mexico. Environmental management in developing countries. Vol. 3

Case study: The Mexican Experience.

The Mexican Experience

In the Mexican Federal Constitution, the state is responsible for national development, through the planning, implementation, coordination and orientation of economic activities throughout the country.

According to social equity and productivity criteria, the state has the right, under the constitution, to support the social and private sectors of the economy, depending upon their type of activity. It must consider the public interest and promote the efficient use of the resources, taking care of their conservation and of the environment in general.

The state has the legal right to impose appropriate measures on private properties in order to serve the public interest as well as to regulate the exploitation of natural elements susceptible to appropriation. The aim of such measures is to achieve an equitable distribution of public wealth, to take care of its conservation, to accomplish the balanced development of the country and to improve the living conditions of the urban and rural population.

The Mexican environmental law, the General Law For Ecological Balance and Environmental Protection, took effect in March 1988, regulates matters concerning the protection and restoration of ecological balance, as well as the protection of the environment in the country.

Economic instruments will yield greater environmental effectiveness if they are able to provide a permanent incentive for pollution abatement and technological innovation.

Source: Andres Flores-Montalvo (Mexico, 1995)

Private sector participation with adequate incentives is a gradual process of disassociating state-owned enterprises or state-provided services from government control and subsidies, and replacing them with market-driven entities. Based on the context of municipal services, privatization implies the reduction of local government activity within the waste management sector by concessions, management contracts, franchise or private entrepreneurship (Kurian, J. et al.2007). Because of public and private sector limitations and inefficiencies like restrictive labour practices, government wage scales, hiring and firing procedures and cost accountability, the government must have the resources and capabilities to monitor performance (service level) and enforce penalties for noncompliant behaviours.

The fear of commercial lenders and private companies in some developing countries to risk their money on long-term or large-scale investments that rely on government payments is a cause for concern. As a result, the central and local governments must act as key players:

-Government must put in place a regulatory framework to protect the private sector against risk such as inflation and political changes, environmental damage and currency adjustments.

-Local governments must be able to generate sufficient revenue to meet contractual agreements with the private sector and protect against economic instabilities.

Policy development for SWM needs to factor economic, environmental and social considerations into decision making processes in prescribing interventions that influence waste handling especially at the source. According to Tjell et al., (1981), while source separation of waste into various components leads to better material recovery with minimum environmental impact, it is more expensive and more inconvenient to households. Ownership of waste is a very important policy and management issue related to waste handling at source. It requires that waste generators legally comply with appropriate disposal procedures prescribed by the waste collecting authority.

The Waste Act of August 27, 1986 of the Federal Republic of Germany, stipulates the ownership of waste and states" Those in possession of household waste or similar type of waste are obliged by law to place it at the disposal of the bodies responsible for its disposal or third parties appointed by them" (Bonomo and Higginson, 1988). Because of this legislative provision, there is proper disposal of waste and explains why Germany has very little problem with improper waste disposal.

3.8 Gender Significance in Waste Management Planning

Solid waste management in most parts of Africa has been largely focused on the technical issues of waste disposal with little attention paid to the social and economic aspects of households. Thus for effective and equitable services, there is need for a paradigm shift in the approach of the service provider. The effects of the different social status of communities especially the role of household is significant and thus planning is crucial for the provision of effective and acceptable service delivery.

One of the key areas that need to be addressed when reviewing the impact of social factors on service delivery is the gender issue. In all societies especially Africa, women have a different role from that of men. Their multiple roles as mothers, homemakers, educators, entrepreneurs and producers place a heavy demand on them particularly the non-elite ones, at a special disadvantage (UNDFW, 1998). It is worth noting that information on the socio-economic status is critical to the solid waste planning process. As a result, if household disposal practices are known, it will be easy to introduce measures to reduce the amount of waste generated by the affected community. Also, an understanding of the diversity of the local culture of home-owners can assist the planning of a domestic solid waste management system**. (**Poswa, 2004)

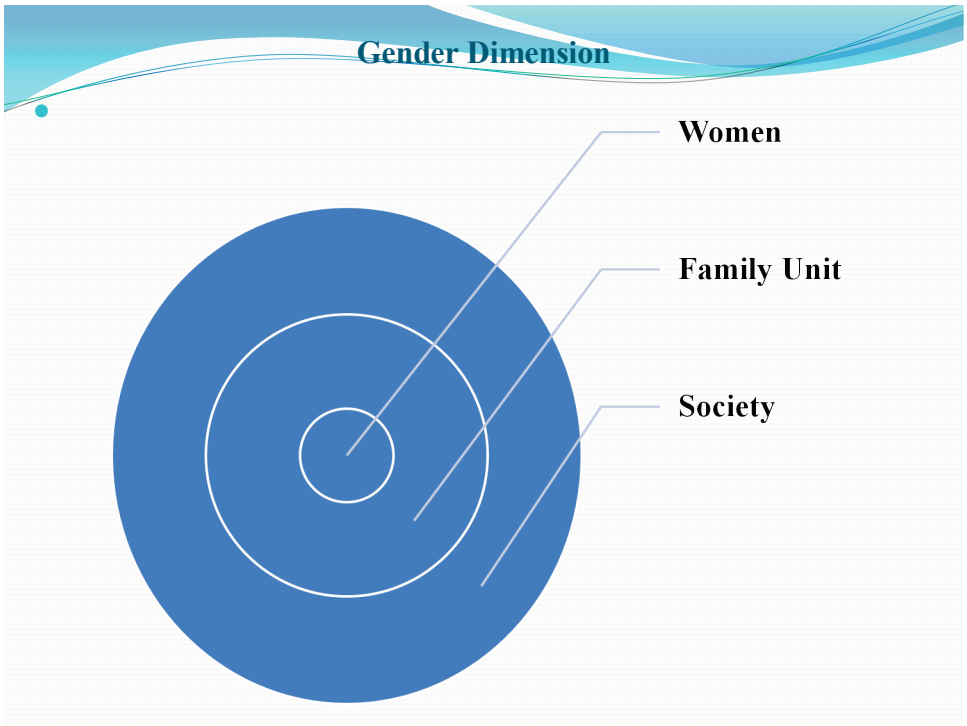


Figure 3.2 Gender Dimension

Research across many cultures has shown that women handle waste in their homes although richer women delegate this task to servants. In most cases, women are not paid to handle waste while men do so when they are to be paid. As a result of their less mobility and access to public space due to cultural and religious reasons, it makes it difficult for them to deliver waste to neighborhood collecting point. Therefore, taking the specific needs of women into consideration in order to ensure their equitable and affordable access to facilities and services is imperative when orientating and directing policies (UNDFW, 1998).The differences between men (drop off centre) and women (door-to-door waste collection system) on the choice of type of waste collection service system is attributed to cultural traditions, which governs gender relations in the households. In most African societies and other developing countries, women are responsible for domestic work like shopping, cooking, cleaning, childcare and wellbeing of their husbands (World bank, 1999)

A comprehensive description of socio-economic factors according to Mayet (1993) stipulates that these factors relate to the state of infrastructural development in a residential area, lifestyle and value systems, aspirations and attitudes, migratory patterns, levels of education and willingness to recycle or reduce waste output. This includes the ability of people to pay for services based on income and willingness to pay (Sadler, 1997). According to the White paper on local government (DCD, 1999), suggestions are made that municipalities should promote job creation and boost local economies by empowering them and developing their capacity to enhance service delivery process.

Addressing social and economic issues require an in-depth review of the existing situation and thorough planning in order to develop performance management plans. This can be achieved by involving affected communities which is vital for the understanding of priority areas (DCD, 1999)

3.8.1 The CLEAR Model

Most governments in the world are experimenting the involvement of citizens in decision making especially at the local level. The goal of such an initiative may vary greatly but the driving force and united factor is to improve on ways in which ordinary people can effectively participate in and influence policies which directly affect their livelihood (Smith, 2005).

According to Lowndes et al (2006b), CLEAR model identifies five factors that underpin citizen's uneven response to participation and argues that participation is most effective if citizens: Can do, Like to, Enabled to, Asked to, Responded to. The model summarizes the five participation factors and sets out an indicative set of policy responses. With this model, each municipality is able to identify the strengths and weaknesses of their own public participation initiatives and existing practices. This reflective evaluation of current practice gives room for municipalities to effect change that will improve participation and reprioritize the attention paid to different factors.

Can Do:

It is based on arguments about socio-economic-status and claims that when people have the appropriate skills and resources, they are more able to participate. These skills range from the ability and confidence to public speaking or letter writing to the capacity to organize events and encourage others of similar mind to support initiatives.

Like To:

It is based on the idea that people's felt sense of being part of something encourages them to engage. According to Putnam (2000), a sense of trust, connection and linked networks can, based on the social capital argument, enable people to work together and co-operate more effectively. To gain an understanding of the sense of loyalties and identities held in various communities serves as an initial step to diagnose their problems.

Enabled To:

According to Parry et al (1992), most participation is facilitated through groups or organizations. The existence of networks and groups which can support participation and which can provide a route in to decision-makers is vital to the vibrancy of participation.

Asked To:

It is build on the research findings that mobilization matters. Mobilization can come from a range of sources but the most powerful form is when those responsible for a decision ask

others to engage with them in decision making. According to Lowndes et al (2006a), the degree of openness of political and managerial systems has a significant effect, with participation increasing where there is a variety of invitations and opportunities.

Responded To:

It is based on the idea that when people believe that their involvement is making a difference and achieving positive benefits, their participation becomes sustainable. This implies that for people to participate, they have to believe that they are going to be listened to and, if not always agreed with, at least in a position to see that their views have been taken into consideration.

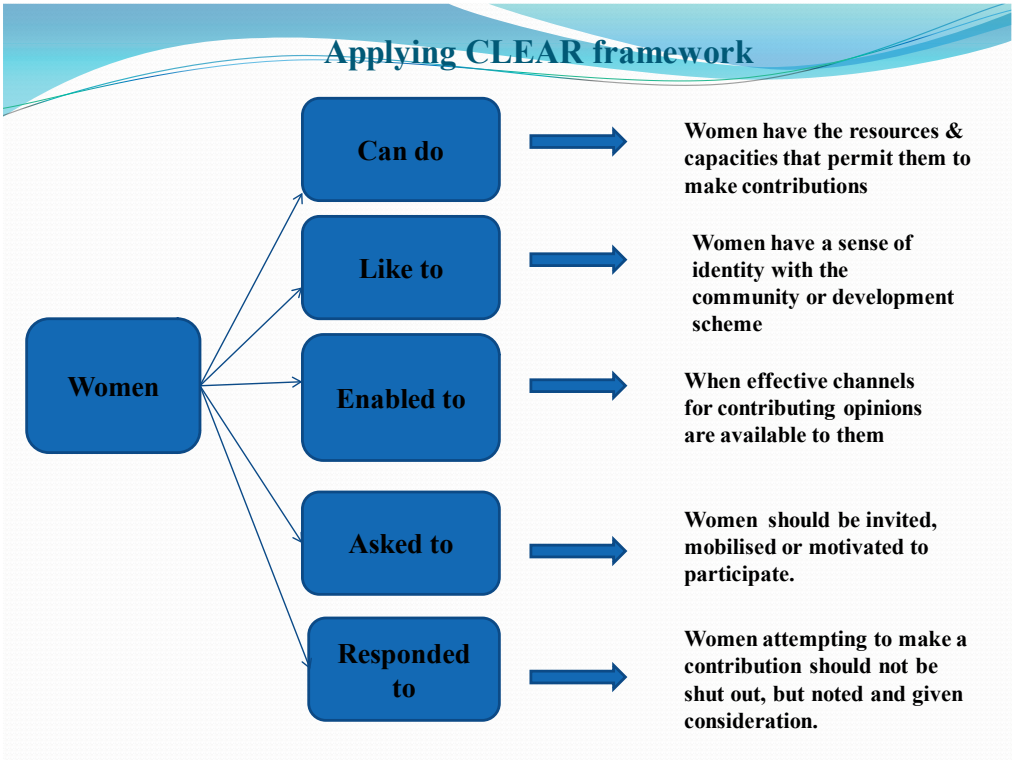


Figure 3.3 Applying CLEAR framework[34]

[34] Lambi, J. N. (2010): 'What Promotes Citizen Participation

The CLEAR enables policy-makers to look at citizens and ask questions about their capacities, their sense of community and their civic organizations. Applying this tool requires three stages of activities:

- It involves refining the questions and challenges to be addressed in any particular setting
- Based on the commitment to a multi-perspective evaluation of the state of citizen participation in the municipality.
- It involves coming to a judgment about priorities in terms of the factors that need to be addressed, and how.

3.8.2 Case Study I (Bottom-Up): KAWWS, Karachi, Pakistan

Dissatisfaction by housewives (1988) with the inadequate service delivered to their (middle/upper) income area took the initiative to arrange for a private garbage collection service in their area. They approached their local politician for support, started a public awareness campaign on public health and garbage among the residents, and established the Karachi Administration Women Welfare Society(KAWWS) to deal with these and related issues. They consider all residents responsible for the creation of waste and thus for proper disposal, even though the dominant Muslim religion enjoins its followers to avoid all contact with waste.

The women have arranged their own van to pick up their waste, despite the fact that taxes supposedly covering this service have already been paid by all the residents. Plans for home-composting or a small composting enterprise in the nearby park, run by some of the waste pickers in the area, are under discussion. Karachi has a significant number of similar initiatives due to the inadequate, highly centralized administrative system of public services.

Source: Ahmed, 1994

3.8.3 Case Study II (Bottom-Up)[35]: Women-run Waste Management and Recycling Programme, Senegal-Africa

Situation Analysis: Existing situation and systems. - Only 35% of the 263 cubic metres of waste in the municipality was collected by the municipal services leading to archaic dumps and chronic poor health. 50.9% of the households had neither WC nor latrines leading to poor sanitation. 76% of the households had no convenient systems to process used waste-water which was consequently poured onto the streets. Out of a targeted population of 44,860 people, the unemployment rate was 28.6% for men and 24.1% for women. There was prevalence of infectious and parasitical diseases. This situation was exacerbated by lack of proponents for urban poverty reduction and absence of skills training for urban women.

Goal: The goal of this initiative was the improvement of the living environment and along with providing income for community women.- Creation of jobs and Encouraging a financial contribution of the beneficiaries in the handling of their habitat.

Process: The absence of such an integrated initiative in the country, the differences in origin and status among the partners were the main difficulties at the beginning. Yet, that proved to be of tremendous help insofar as, at first, the initiative was tailored to the needs and capacities of the participants, and then the diversity of origins allowed to take into account multiple aspects of it (agronomic, sociological, statistical, legal, gender, etc.)

Results: -a regular collection of the waste, and eradication of anarchic dumps, an improvement of the sanitary and nutritional status of the beneficiaries. - Greater mobilization of women who are now more confident in their capacity to take their emancipation in their own hands. - Widening of the women's technical scope through exchange visits and an active and efficient participation to national and international celebration days.

This initiative won the Grand Prize of the President of the Republic of Senegal for the Promotion of the Senegalese Woman, 1998 Edition, on the theme of "Cleanliness and Management of our Habitat: the Response of Women"

[35] Women-run Waste Management and Recycling Programme, Senegal-Africa http://www.unhabitat.org/downloads/docs/2212_84897_Women.pdf, accessed May 2012

Chapter 4: RESEARCH DESIGN & METHODOLOGY

The pivotal idea of this research methodology is to develop a Bottom-Up approach which ranges from the identification of waste generators, capacity building/participation , Choice of technology and policy options that enhance sustainability of waste management. In order to achieve the research objectives, information from national, regional and community levels of society was gathered through qualitative and quantitative research methods. Qualitative information was gathered by in-depth interviews with institutions and stakeholders having different roles within the SWMS. Quantitative data was gathered by means of a questionnaire survey conducted on the household and individual level within the chosen study area. While secondary data relevant to SWM in Cameroon & African countries were assembled from national and international statistics, reports, and studies.

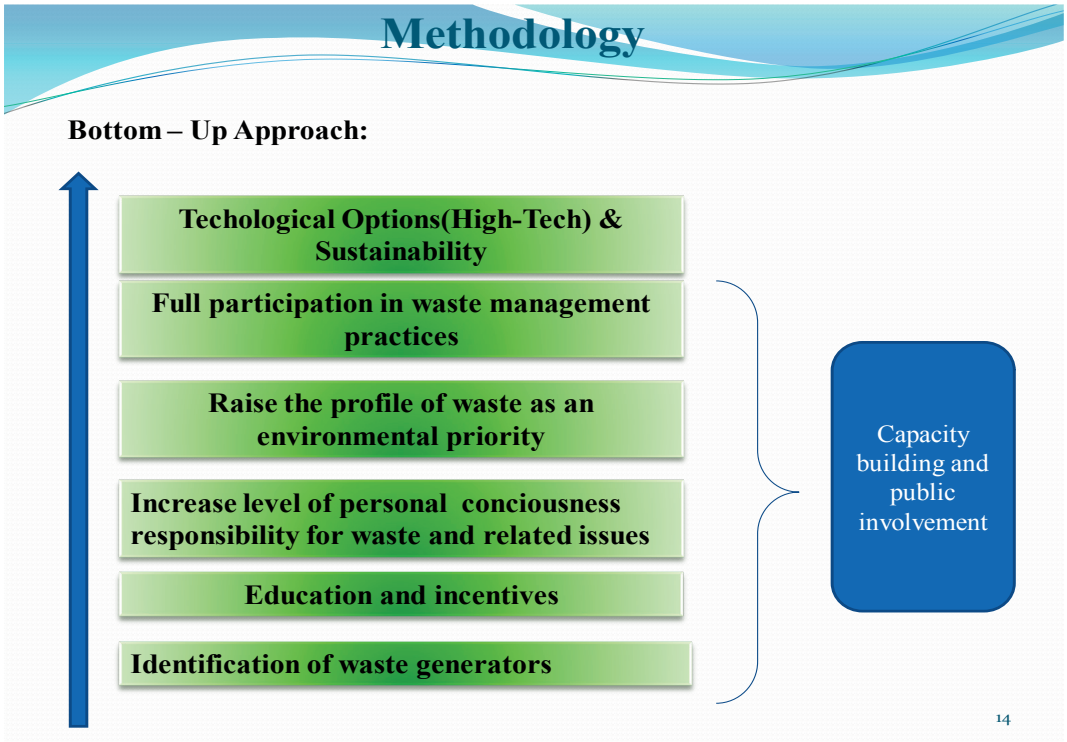


Figure 4.1 Bottom-Up Approach

Summary of methodology

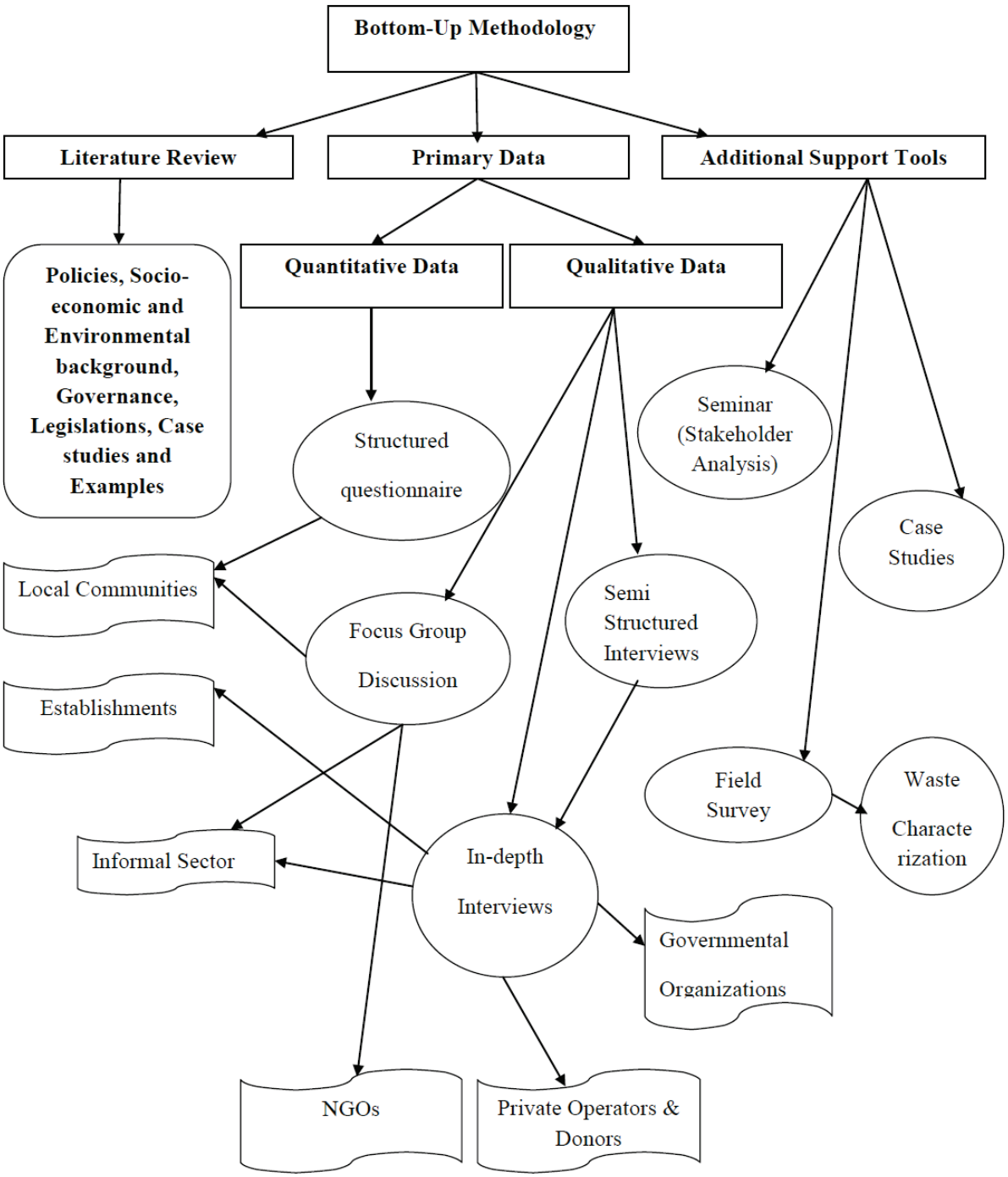


Figure 4.2 A summary of research methodology

This research was done in 2009 and 2010. The study was carried out using five principle approaches:

4:1 Secondary Data Collection (Literature Review)

The review of secondary data has been very useful for this research. Firstly, a desk studies which involved the consultation of official reports, articles, legal documents, published and unpublished literatures and Case studies. The information accessed, captures a wide range of issues around MSWM which include: socio-economic, legislative, regulative and political issues.

4.2 Primary Data Collection (Quantitative)

The study consists of solid waste produced by household sector and managed by the rural council. It is based on primary data survey in 2010 and 80 households were interviewed with the help of questionnaires in the geographical area of Buea. Questionnaire measured household existing solid waste practices as well as individual knowledge, attitudes, concerns, willingness to participate and regarding general issues on solid waste. Interviews were conducted among adults aged 18+ face to face at respondents own homes throughout the metropolitan city of Buea. Interviews took place between 9:00am and 6:00pm daily.

The research at the 80 households was obtained by a stratified random sampling technique. The sample distribution was selected such that it reflected both a representative sample size and the heterogeneity of the study population due to different socio-economic circumstances (3 –Zones: High income, Middle income & low income). A descriptive survey across the section of the population involving personal interviews was used to collect data. The rationale for the selection of households was based on the following reasons:

- Household is one of the most important institutions in a society and within which the gender norms are expressed, reinforced and reflected in large institutions of society.
- Household is a basic unit of society where individuals both cooperate and compete for resources (World Bank, 1999).

As a result, an understanding of the effects of social factors on service programmes can be examined through households.

Table 4.1 Data Collection Methods

Data Collection Methods[36]	
Study Object	**Method**
Household Structure: Employment, education, property ownership	- Household Survey questionnaire - Observation
Waste characterization: - Waste Composition - Per capita generation	- Waste analysis by manual sorting. - Measure each waste component - Calculate per capital generation and total amount - Observation
Household SWM practices: Storage, resource recovery, collection and disposal	- Questionnaire - Interviews - Observation

According to Kapoor (2009)[37], an attitude can be defined as inclination towards some object. It is relatively permanent characteristic of human personality and is decided by the basic value system, core beliefs, biological and psychological background, socialization process and environmental experiences. Attitude is a major determinant of decision-making behavior.

4.3 Field Survey – Exploring Different Habitat Scales

Field survey was done at different habitat scales aim to identify the functional elements existing within the management of MSW in Buea and to investigate waste management practices. The different habitat scales that needed to be integrated are the premise (household) level, Neighborhood level and City level.

This survey included:

- A visit to all old and present municipal dumpsites.

[36] Aisa S, 2010. Household solid waste characteristics and management practices in Dar es Salaam, Tanzania

[37] Public attitude towards solid waste management – An Empirical Analysis. Proceedings of international conference on energy and environment March 19-21, 2009 ISSN: 2070-3740……..12.03.12

- A visit to schools, hotels, clinics and hospitals

Qualitative research methods like semi and unstructured interviews, fieldwork and observation were conducted.

In order to find out the role of the informal sector in waste management,

- Unstructured interviews were conducted with the informal waste collectors during field visit at residential, commercial areas and dumpsites.
- Unstructured interviews were conducted with leaders of organized groups of collectors and middlemen.
- Unstructured interviews were conducted with council workers uncharged of waste management (sanitation) to evaluate and assess their effectiveness and efficiency.

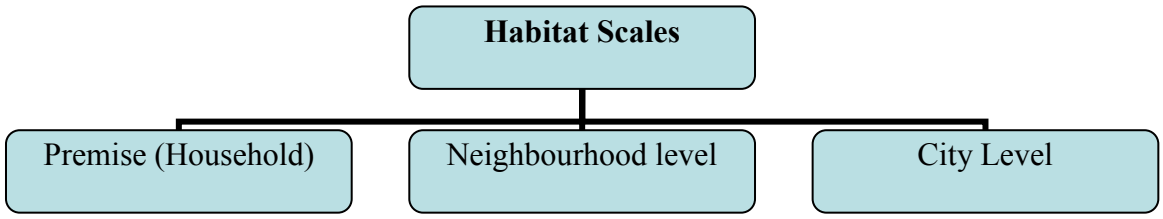


Figure 4.3 Habitat scales

An efficient integrated system uses a range of inter-related collection and treatment options and takes into consideration interactions between the waste management system and other urban systems.

Table 4.2 Habitat scales and activities in an Integrated Sustainable Waste Management System

Habitat Scale	**Collection and Disposal System**	**Resource Recovery System**
Premise Level	Storage at source	Prevention Separation at Source Reuse at Source
Neighboorhood Level	Primary Collection Temporary Storage	Primary Collection Sorting and Pre-treatment Reuse

		Recycling Composting
City Level	Secondary Collection Transfer Storage Tertiary Collection Final Disposal and Treatment	Sorting and Pre-treatment Secondary Collection Reuse Recycling Composting

Source: Arnold van de Klundert, Anschutz, J. 1999

The use of different collection and treatment options, at different habitat scales, can form the basis of a system that is adapted to local[38] conditions.

4.4 Focus Group Discussion

Group discussion was carried out with structured questions at the Baptist Church Molyko Buea in 2010. Data collection was both quantitative and qualitative in nature. The CLEAR model was used for self evaluation of gender participation. According to Lowndes et al 2006b, CLEAR model identifies five factors that underpin citizen's uneven response to participation and argues that participation is most where effective citizens: Can do, Like to, Enabled to, Asked to and Responded to.

Table 4.2.1 Participation factors and Indicative set of policy responses

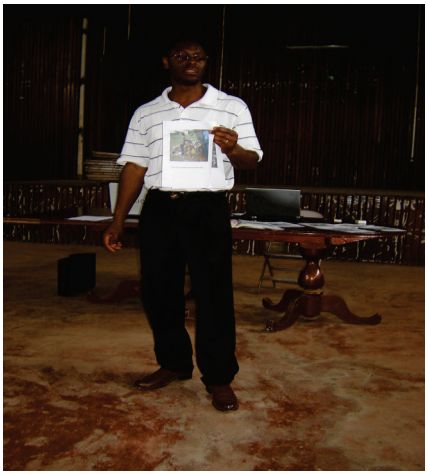
Participation Factors	**Indicative Set of Policy Responses**
Can do	have the resources and knowledge to participate
Like to	have a sense of attachment that reinforces participation
Enabled to	are provided with the opportunity for participation
Asked to	are mobilized through public agencies and civic channels
Responded to	see evidence that their views have been considered

[38] Physical, Social and Economic

4.5 Waste to Cash Seminar – Stakeholders Analysis

This involved the organization of a seminar at the Bilingual Grammar School (BGS) Molyko Buea. Publicity was done on the state radio corporation (CRTV-Buea) during the pidgin news slot and the private radio (Revival Gospel Radio). The pidgin news is the most attracted and listened to news slot in Buea.

Seminar was aimed to bring the public especially stakeholders for public discussion to get public opinion about waste management in Buea and possibly other cities in Cameroon. This seminar was done after field survey and visitations were conducted. It was enhance by the use of pictures taken during field survey so that stakeholders would see the true state of waste disposal and be awakened. Some pictures used during seminar can be seen below:



Seminar at BGS Molyko

Stakeholders at Seminar

Figure 4.4 Waste to cash seminar

4.6 In-depth Interviews

Indept interviews targeted stakeholders and decision-makers in the field of SWM at regional level.The stateholders were chosen based on the respective role within the SWMS. Qualitative information was provide by respondents concerning the existing SWM system as well as the factor that may influence public participation. The interview guide was specific to the respondent and their role in solid waste management. The quide questions were soly open-ended. Interviews were personally conducted by the author of this thesis. In some cases on phone and it lasted between 10-25 minutes.

4.7 Overview of Waste Management Situation in Cameroon

The extent to which developed and developing countries are coping with the problem of waste management varies. Most developed countries have sought for effective management approach like the solid waste hierarchy while developing countries are overwhelmed with the problem and are still at the primary stages of it (Achankeng, E., 2004[39])

Table 4.3 Country Statistics - Cameroon

Statistics	Indicator	Year
Physical area	475,442 km^2	
Population		
Total population	16,647,000	2003
Rural population	48% of total population	2005
Population density	39.0 inhabitants/km^2	2003
Population economically active in agriculture	60.6%	2000
Per capita GDP	USD 1,019.0/year	2004
GHG emissions (kt of carbon	2963	2004

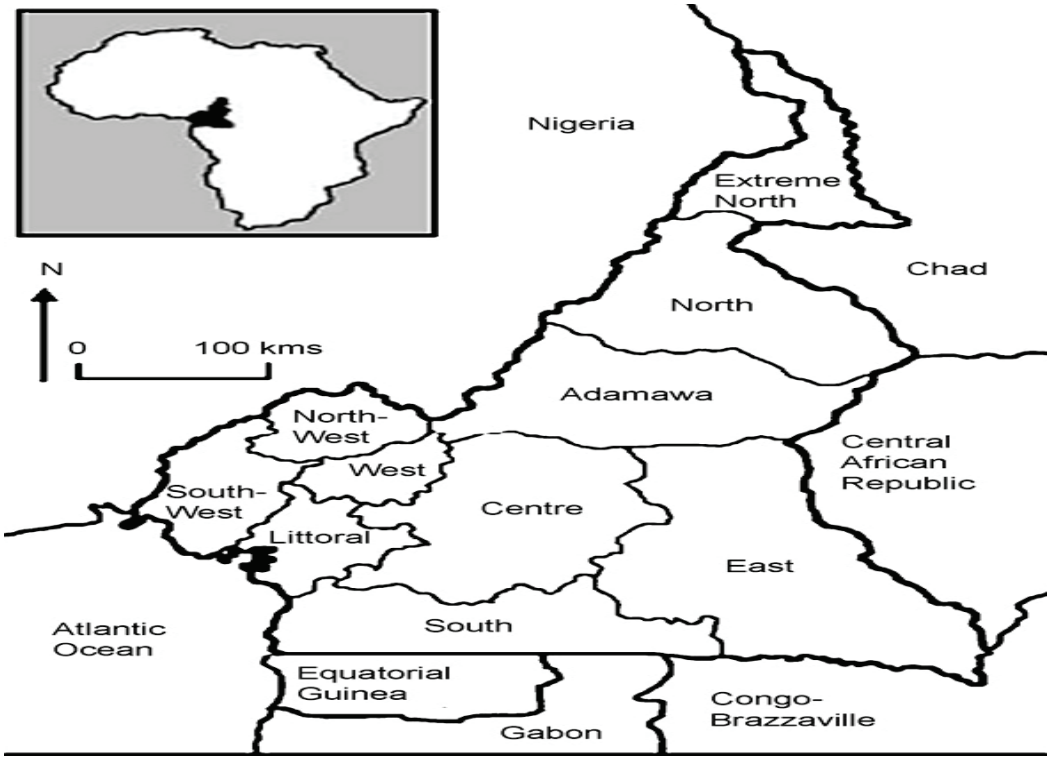
[39] Sustainability in municipal solid waste management in Bamenda and Yaounde, Cameroon-pdf—27.03.12

dioxide per inhabitants)	0.18kt per inhabitant	
Literacy Females Males	68% 55% 83%	2001

Source: Ngnikam, et al. (2009)

Cameroon is located in Central Africa on the Gulf of Guinea, between longitudes 9^{o} and 16^{o} east. The country has a surface area of 475,650 Km^{2} and its population is estimated at 16,647,000 as of 2003 with 50% living in urban areas. Its diverse geography consists of several types of natural environments[40]. Thus Cameroon is considered by many as a microcosm of Africa or Africa in Miniature.

Figure 4.5 Map of Cameroon showing the international and provincial boundaries

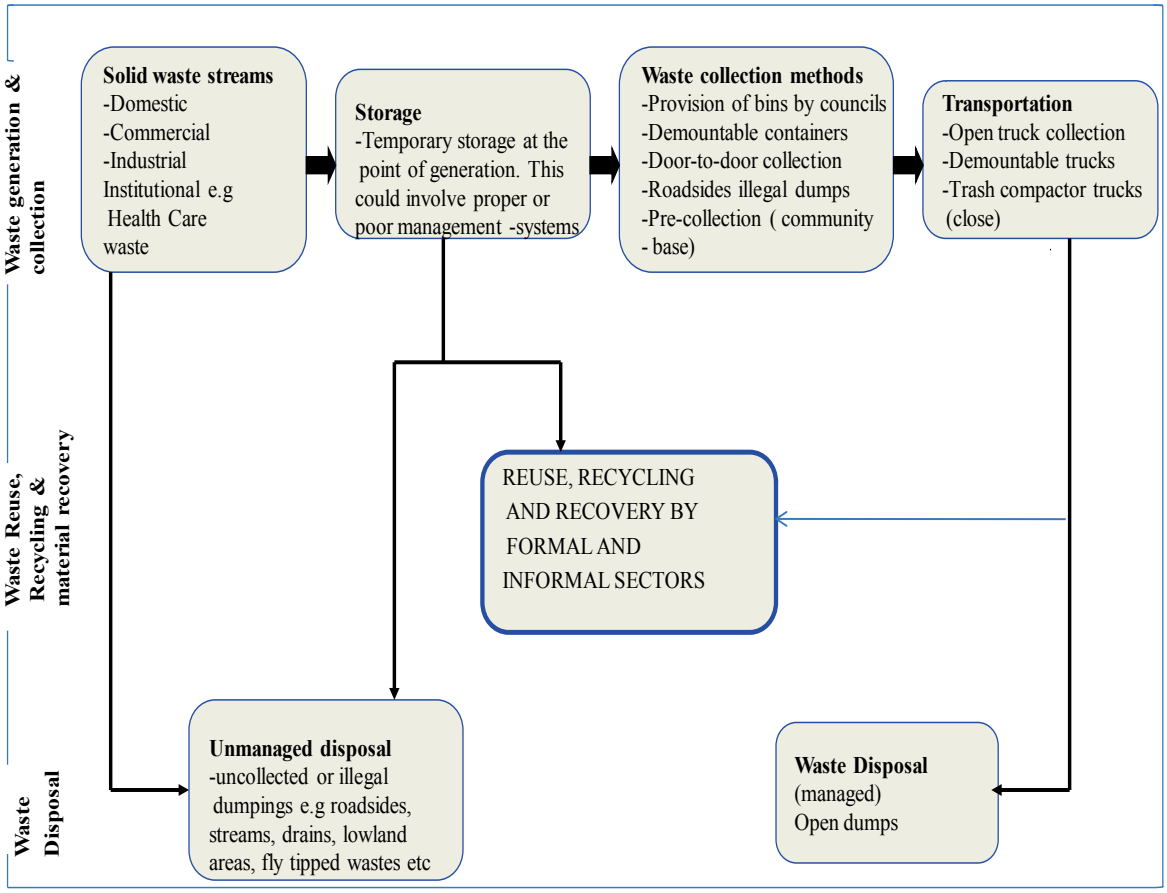


Source: Page, 2003

[40] The southern forest(maritime & equatorial areas), The western high plateau(western and north-western regions-volcanic soils), Northern Sudanese-sahelian region(Adamaoua, northern and extreme northern part-area of savannah & steppe)

Like most developing countries, Cameroon is facing high rates of urbanization estimated at about 4% annually, compared to annual population growth of about 2.7 % (World Bank, 2002). Rapid urbanization is occurring in a period that the country is experiencing socio-economic pressures especially in the last two decades. The National Structural Adjustment Programs of the early nineties resulted in limited government financial resources. The outcome is evident in the fact that the government has drastically reduced its investments and subsidies in the urban sector (Manga, 2007)[41]. Unlike most developing countries, waste management services in Cameroon are limited to collection, transportation and final disposal at dumping site. The recycling of waste is insignificant and public participation in waste management is 40-50 % as the populace believes that it is the primary responsibility of the Council or private company to manage waste.

Operational framework for Municipal Councils in Cameroon



Source: Existing patterns of solid waste management in Cameroon (Manga et al)

Figure 4.6 Operational framework for Municipal Councils in Cameroon

Waste management in Cameroon on the most part is the responsibility of the local council. However in some cities like Douala, Yaounde, Baffoussam, Limbe, Garoua and presently Buea, the private hygiene and sanitation company HYSACAM takes care of the collection and treatment of municipal waste. According to Kemajou (2007) the quantity of waste collection represents 40% of waste produced and is constantly on the increase.

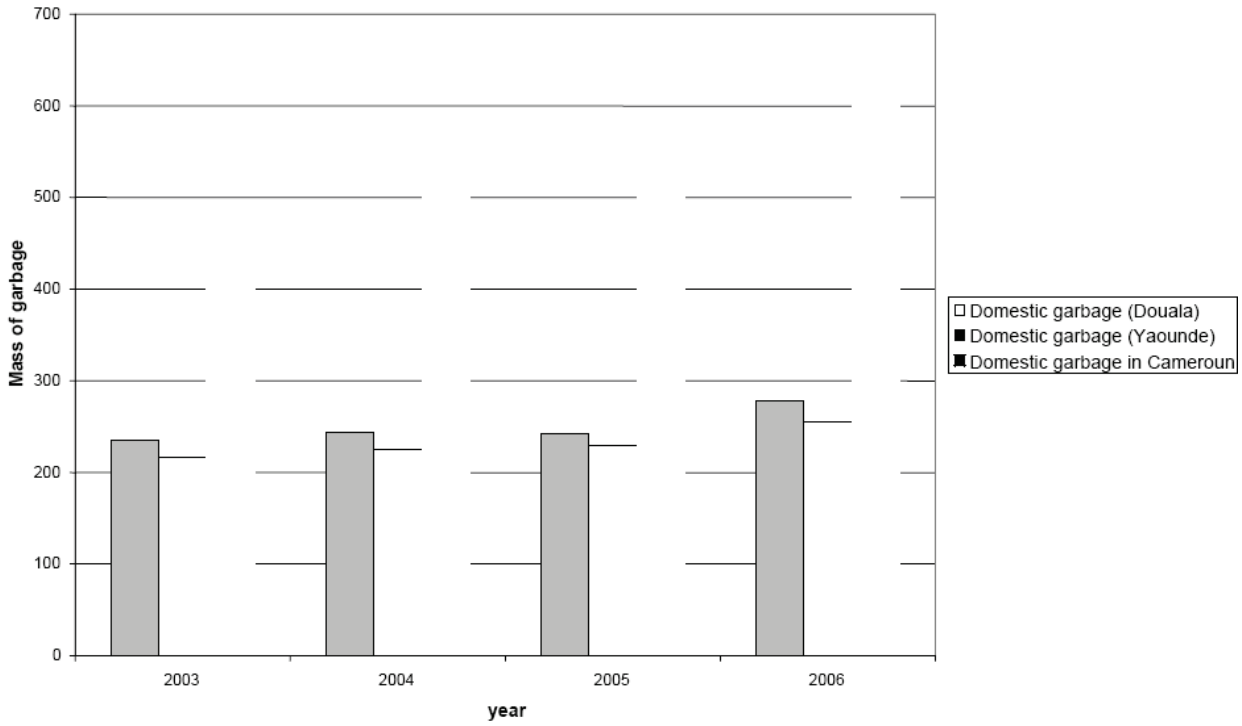


Figure 4.7 The Evolution of household waste mass collected by HYSACAM

Domestic waste collected by HYSACAM consists of the following proportion: fermentable fraction (78.8%), inert fraction (10%), and combustible fraction (11.2%). HYSACAM exploits several dumps and the main ones are found in the vicinities of Makèpe and PK10 in Douala and Nkolfoulou in Yaounde. The density of waste entering dump according to Kamajou is approximately 4.5 KN/m^3 and the waste is characterized in the table below.

Table 4.4 HYSACAM Waste Composition

Fractions	Average (%)
Wood	0.82
Rubber	0.59
Paper	9.86
Gravel	0.91
Metal	1.26
Plastic	8.34
Textiles(leader & cloth)	4.26
Glass and ceramics	1.13
Organic matter	65.79
Finished elements (< 20mm)	6.95
Hospital waste	0.08

Source: Kemajou, 2007

Solid waste in Cameroon can be broadly classified into three main categories:

Domestic refuse: solid waste generated by households, food centers, markets and commercial premises such as hotels, shops and restaurants.

Institutional refuse: solid waste from hospitals, schools, recreational facilities, public development projects, various government and statutory Board installations.

Industrial refuse: excluding toxic and hazardous waste that requires special handling, treatment and disposal.

The composition of waste fluctuates according to a few factors:

- Season: - In the rainy season, there is a high amount of food, fruit and vegetable waste and thus, waste has a high organic content.

- Affluence – As in most parts of developing countries, solid waste from rural areas where people are poorer has a higher percentage of organic matter, about 70-80%. Unlike in urban areas where people are affluent, the waste has approximately 60% organic matter with an increase in non-degradable materials such as plastics, metals, and glass.
- Location: - Market streets generate more organic waste than business quarters.
- Cultural Activities:. Women's day, Christmas and New Year celebrations result in more organic waste generation due to the amount of flowers, trees etc bought for the occasion.

It is worth noting that not only has the composition of waste changed, but the amount of waste generated also differs.

Table: Waste governance in selected African Cities and Cameroon

Country	**City**	**Waste governance setting**
Cameroon	Douala	Privatized
-	Yaounde	-
-	Limbe	-
-	Baffousam	-
-	Garoua	-
-	Buea	-
-	Bamenda	Council
Nigeria	Ibadan	State run and privatized
Tanzania	Dares Salaam	State run and community based
South Africa	Johannesburg	Community based and privatized

Ivory Coast	Abidjan	State run and privatized

Source: Onibokun, 1997 & Asi, 2012

4.7.1 Study Area – Buea, South West Region Cameroon

Buea, the capital of South West Region and former capital of Southern Cameroon is located at the foot of Mount Cameroon and has a population of 200.000 inhabitants. It was the German colonial capital between 1901 and 1909. Buea later on became the British protectorate, Southern Cameroons and lastly the capital of the Southern Cameroons and West Cameroon between 1954 and 1972, respectively. Buea is made up of a constellation of 85 villages and inhabited by Bakweris, who based on social scientists have lived around the mountain for at least 4000 years.

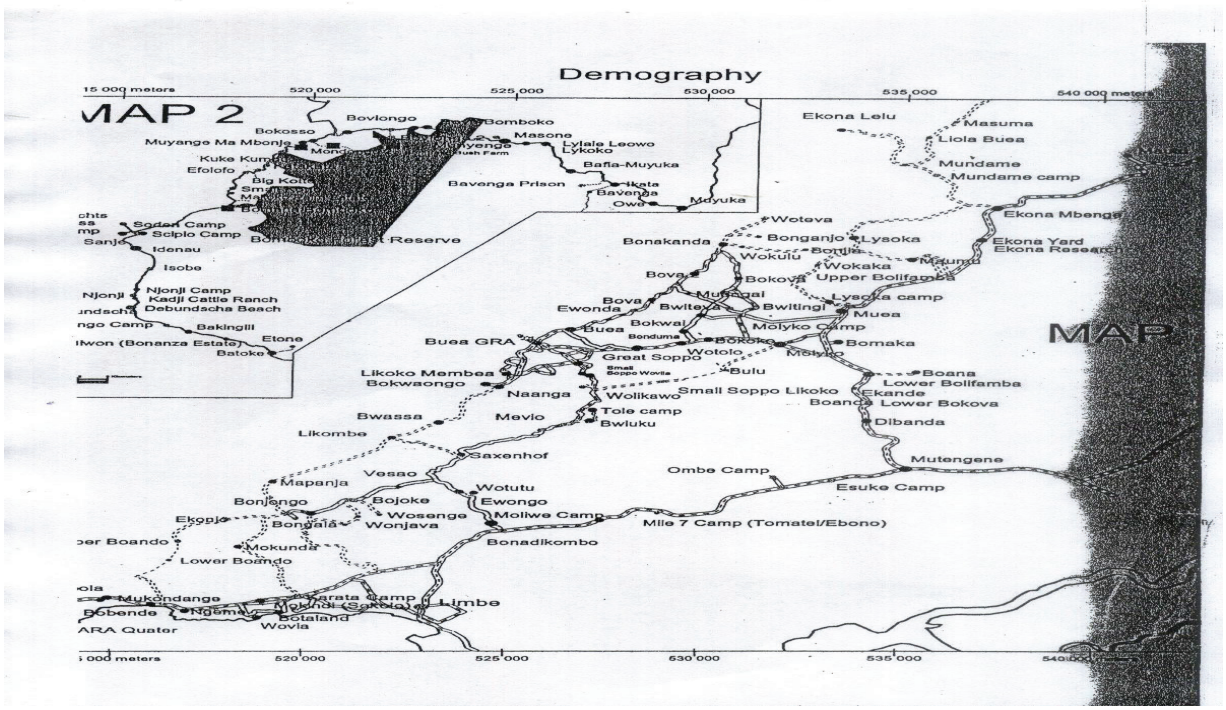


Figure 4.8 Map of Buea – South West Region Cameroon (**Source**: Buea Council, 2009)

Buea is made up of a constellation of 85 villages and inhabited by Bakweris, who based on social scientists have lived around the mountain for at least 4000 years.

Buea is one of the fastest growing towns in Cameroon at the moment. Its urban rims include: Molyko, Buea town, Muea, GRA, Mile 16, Clerk's and Federal Quarters, Great Soppo, Likoko-Membea, Bokwaongo and Bonduma. It is worth noting that Buea is the home of academic excellence, making its locals to have education as one of its priorities. Molyko is the worst hit area (Appendix 4)

- Geometric rate of population growth as a result of the coming in of the University of Buea and other tertiary institutions.
- Lack of space for proper waste disposal and management.
- Lack of necessary technology for collection, transportation and processing of waste for useful purposes.
- Financial constrains of the council to solve the ever-increasing quantity of waste produced from various sources

CHAPTER 5: Results, Analysis and Discussion

The analysis that follows is guided by critical literature and reports available in libraries and internet. The information gathered from the in-depth interviews and results from questionnaire survey were synthesized along with the secondary data in order to develop a bottom up approach. These questionnaires and interviews were conducted in Buea to ascertain household disposal method, and levels of satisfaction with and impacts of SWM system. Participatory appraisal methods were also used to collect data.

This chapter presents qualitative information and quantitative data particular in describing the existing SWM system. Analyzed quantitative data using Microsoft Excel are presented in charts, while pictures, tables, detailed cases, maps illustrate major arguments.

To better understand the waste management system of Buea, exploring habitat scale was one of the best options. Different habitat scales were identified and this included; household level, quarter level and city level.

5.1 Waste management activities at each habitat scale in Buea

Table 5.1 Showing waste management activities at each habitat scale in Buea

Habitat Scale	**Collection & Disposal System**	**Resource Recovery System**
Household or premise level	Storage at Source(E)	Prevention(E) Separation(E) Reuse at source(E)
Quarter or Neighborhood Level	Primary collection(E) Temporal storage(E)	Primary collection(E) Sorting(E) & pre-treatment(N/E) Reuse(E)

		Recycling(E) Composting(E)
City level	Secondary collection(E) Transfer storage(N/E) Tertiary collection(N/E) Final disposal(E) and treatment(N/E)	Sorting(N/E) and pre-treatment(N/E) Secondary collection(N/E) Reuse(E) Recycling(N/E) Composting(E)

E – Evident N/E – Not Evident

A typical waste management system in Buea is described by the following elements:

- Household waste generation and storage
- Reuse and composting on household level
- Primary waste collection and transport to communal bin
- Secondary collection and transportation to waste disposal site
- Waste disposal in landfill (open dumping).

It is worth noting that the techniques for taking care of waste by citizens in Buea are different depending on differing levels of collection service.

Household Level:

In almost every home in Buea, storage of waste is done in one way or the other. Storage containers like plastic buckets are kept in the kitchen and in some cases; plastic bags (mocuta bags) are keep at the backyard in order to store waste. Primary waste collection and transportation to communal bins is regular that is, at least every two days. Above 70% of waste is organic.

Figure 5.1 Household waste characterization in Buea

The separation of waste is evident in most homes because items like plastic bottles and cans are used for other valuable purposes like the storage of cooking oil and fuel. Hardly can one find e-waste at homes because electronic materials are mostly taken to local electronic shops for repairs.

Neighbourhood Level

Primary collection of waste is done in two ways; some homes could afford to pay private waste collectors (Pic.A) who come around twice a week for collection. In other homes, children(Pic.B) are assigned to transport waste to communal bin.

Pic.(A)Primary Collection & Transportation Pic. (B) Primary collection & Transportation

Figure 5.2 neighbourhood level primary collection and transportation

It is worth noting that although there are communal bins at strategic locations in the city, only about 30% of household waste reach these bins.Waste disposal is largely based on the

availability of space. Some waste are used for the purpose of composting while most waste are dump in nearby streams or bush. Recycling at local level is done by a few blacksmiths who reuse aluminim and iron containers to manaufacture cooking pots and other utensils. It is also done by mechanics who reuse aluminium and iron materials for car repairs. Composting is a common practice in Buea but not done on commercial scale.

City level

At the city level, there is no pre-treatment of waste and resource recovery system are not available.Secondary collection of waste from communal bins is not done on a daily basis and most of the time, waste is found litering on the ground. In Buea, there is no transfer station and waste from communal containers are tranfered by trucks to final disposal sites. Like most of the cities in Cameroon, open dumping is the most preffered method for the final disposal of municiple waste.

Communal Bin Molyko Council Truck Final Disposal-Open Dumping

Figure 5:3 Communal bin and open dumping

Open dumping still remains the cheapest and most effective solution to get rid of rising heaps of garbage. The present disposal site is distantly located from source of waste generation. This has led to increase transfer costs due to longer collection and hauling time. Additional investments for road infrasture will only intensify the financial problems of the council. According to council workers in charged of waste collection and tranfer, sometimes petrol

money is not available and this greatly hampers service resulting in irregular collection of waste in the city.

5.1.1 Waste Managemnt Practices

Waste management practices in Buea varies from place to place, quarter to quarter and institution to institution. Because of weak policy implementation, limited communal bins and lack of financial resources for efficient and effective services, people have resorted to manage waste in a way that is best for them. Within the same city, different waste management practices were observed.

Baptist High School – Pit dumping for burning

Buea Regional Hospital Annex-Pit dumping

Mount Mary Hospital – Local Incinerator

Neigbourhood – Stream Dumping

Figure 5.3 Differences in waste management practices based on location

On most of the campuses in Buea, pit dumping is common place. This is largely due to the availability of land.

In effort to separate medical waste from Buea main waste stream, hospitals have resorted to the burning of medical waste in open pit at fixed location around hospital premises. In some cases, hospitals and clinics have constructed local incinerators for burning of waste. It is worth mentioning that the incinerator that waste was installed in Buea regional hospital by the chinesse got bad because of lack of technical skills. This is an indication of the consequences of Top-down approach.

5.1.2 Composting and Recycling

In Buea, Composting is the second preferred method of solid waste management. This is due to the high percentage of organic material in the waste composition.In the whole region, there are no compost plants and composting for agricultural purposes is not done on commercial scale. High operating and maintenance costs, incomplete separation of waste and lack of effective marketing makes composting less attractive.

With increasing urbanization, lack of space and cultural shift toward disposable plastics, there is dcrease in household segregation. In some quarters with available land, organic wastes are composted at the backyard. The burning of combustible waste such as plastics, cardboard and paper at designated areas is widely practiced. With these methods typically used for final disposal, the overall condition of dumpsite(uncontrolled landfill) is still unsatisfactory.

The informal sector “waste pickers” are those who widely practice recycling. The existent and profitability of market systems rely on recycle-material throughput, involvement of small business, middlemen, and large industries and exporters. Composting and recycling programmes require a supply of raw materials or feedstock and demand for the final product.The lack of markets for these materials is viewed as a challenge to new and existing composting(Zurbrugg, 2002)

5.2 Household Waste Management

5.2.1 Level of education of the most educated member of household

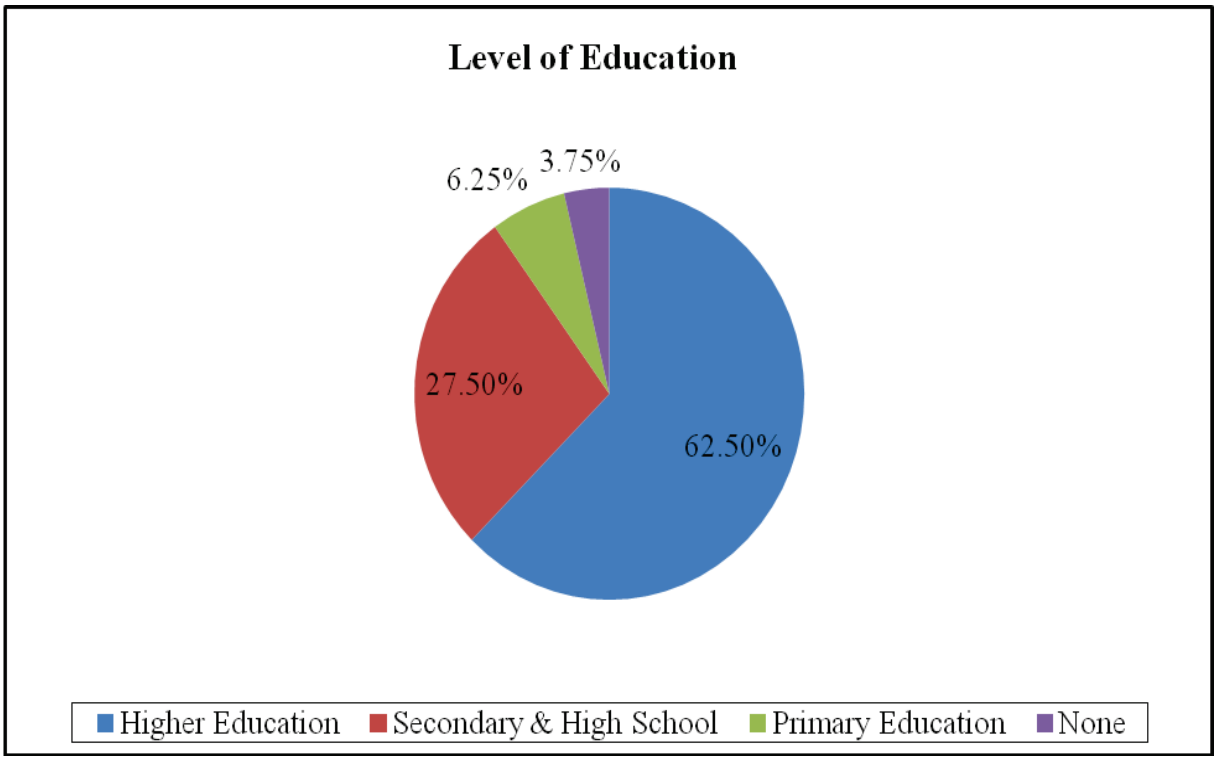


Figure 5.4.1 Level of education of the most educated member of household

6.25% of sampled population did only primary education, 22.5% ended education at the level of secondary and high school, 5% attended technical or professional education and 62.5% have been to the University. The overwhelming majority of 62.5% is an indication that Buea is an academic center thus access to environmental information and the spread of environmental ideas will thrive in such a metropolitan city –through print media. Such and educated community offers a platform for Bottom-Up approach to waste management.

According to Les Robinson et.al. (2002), local authorities should express an interest in community education, public relations and social marketing approaches to fulfilling this educational need. These three aspects use similar tools such as print products, media stories, advertising and direct mail etc.

- Community education seeks to answer the public's need for **information.**
- Public relations seek to influence the public's **attitudes** towards a brand or product.

- Social marketing seeks to promote social beneficial **behaviours.**

It is worth noting that while education campaigns deal primarily in facts, the other approaches seek to influence choice, relying instead on selling an idea by selectively reporting facts. These approaches are very useful in the choice of technology. The best way to enhance waste strategy campaign in Buea will involve the distribution of information materials to the community (inform), consultative surveys with the broad community (Consult) and community workshops (involve).The more open, inclusive and deliberative the process, the greater the capacity to deal with complex information, elicit community values, solve problems and resolve conflicts.

5.2.2 Availability of information about solid waste management system

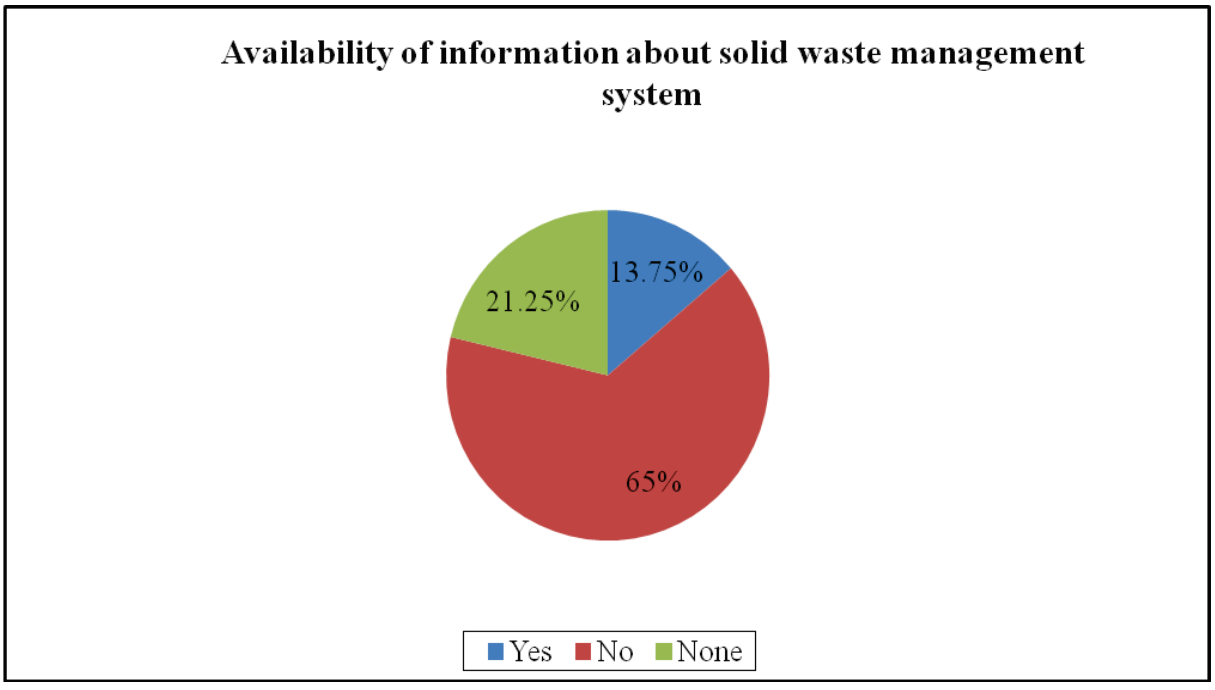


Figure 5.4.2 Availability of information about solid waste management system

13.75% had available information about waste resource recovery, risks associated with improper waste handling, 65% had no information and 21.25% acknowledged their ignorance. This results indicate that the Council does very little to provide information to homes

concerning waste management. It is also a sign that environmental campaign in the city of Buea by the Council and all stakeholders on waste issues is low.

It was startling to know that in such a literate city like Buea, people lacked basic information on solid waste management systems(Hygiene & sanitatin). Where information gaps are a problem and need of knowledege is relatively certain, it implies information campaigns are appropriate. This information gap is due to lack of trained personels and finances. To inform society involves education and awareness campaigns. Knowledge of waste management methods can either motivate individuals to participate in waste reduction or inadequate knowledge can be a barrier to waste maagement behaviour. In a study investigating motivating factors and barriers to recycling by Simmons and Widmar (1990), the lack of knowledge and a lack of personal salience and efficacy were barriers that interfered with the motivating effect of a person's sense of responsible action and conservation ethic.It concludes that without information and perception of individual ability to reducce waste, the individual will not act on their internal sense of responsibility by participating in waste reduction programms.

The target of Buea council should be to improve public understanding by providing the public with information on waste management and increase awareness about waste management strategy and system. This can be achieved through the use of brochures, websites, seminars, media stories, advertisements, fact sheets, stalls and public information nights.

Les Robinson, 2002 furher suggesst that there are different situations which require waste management communication, each having a different purpose and each requiring a customised engagement strategy(Appendix 5-Table) Strategic situation for waste management communication

Increasing the knowledge of waste reduction for the target population is seen as a necessary method of increasing public participation in waste reduction.

5.2.3 Awareness of Type of Container used for storing waste at home

Designing an efficient collection system needs a careful selection of type and size and location of containers. Small containers were used for single-family households and required manual handling while large and heavier containers required mecahised handing.

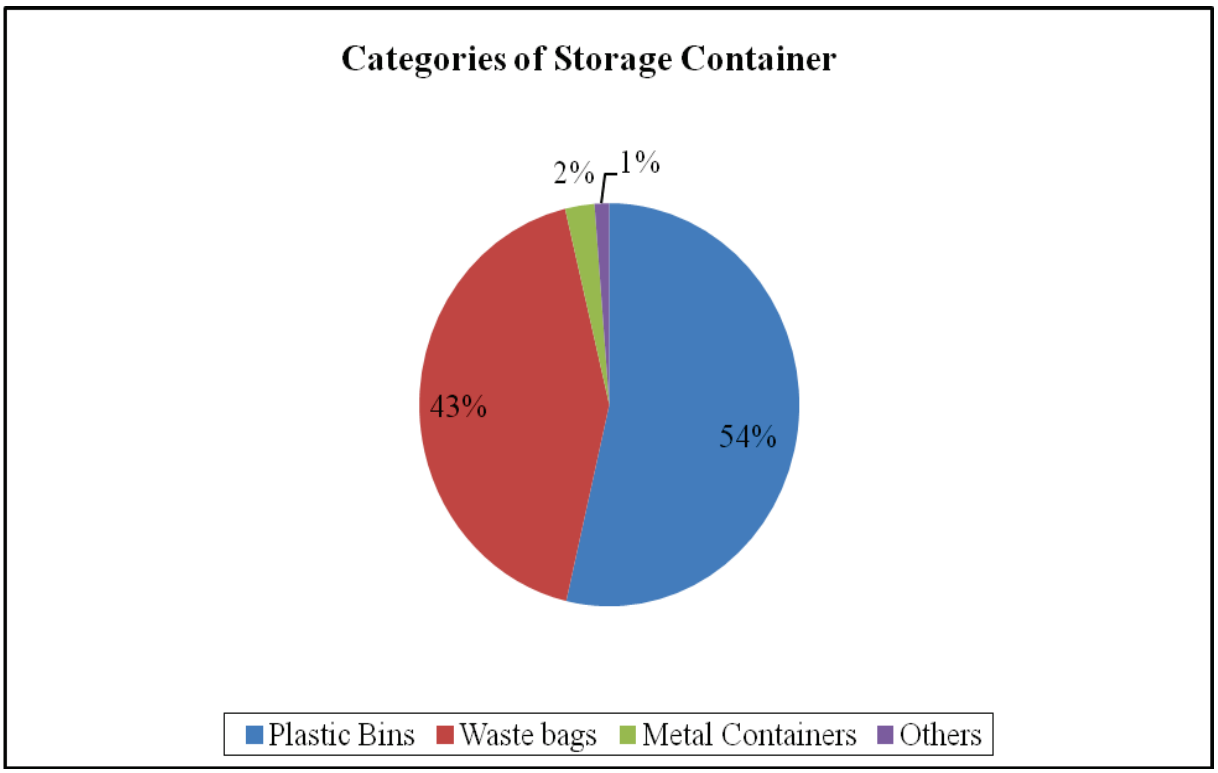


Figure 5.4.3 Categories of storage containers

53.75% of the sampled population stated they use plastic bins for storing waste at home, 42.5% use bags (mucuta), 2.5% made use of metallic containers and 1.25% other items. Plastic bins are easily handled and at the end-of-life, can easily be melted and used for other purposes. Solid waste must be stored first before they are collected. A good on-site storage container must have the following characteristics:

- Keep waste properly contained to avoid health hazards. This implies that waste will not tip over easily with contents spilled out.

-It should make collection easy and should be aesthetically pleasing.

It is worth noting that the quality of solid waste containers also affects the collection frequency. For closed containers, collection frequency can be allowed for up to three day, whereas open and unsealed containers may require daily collection. Residential waste usually contains food and other putrecible materials. Because of health and aesthetic reasons, frequent collection of this waste is desirable.

Plastic bin and bags are the most used storage containers in Buea because they are durable, easy to handle, economical as well as resistant to corrosion. Waste bags are also used because they are cheap and easy to handle.

5.2.4 Public concern about communal waste container

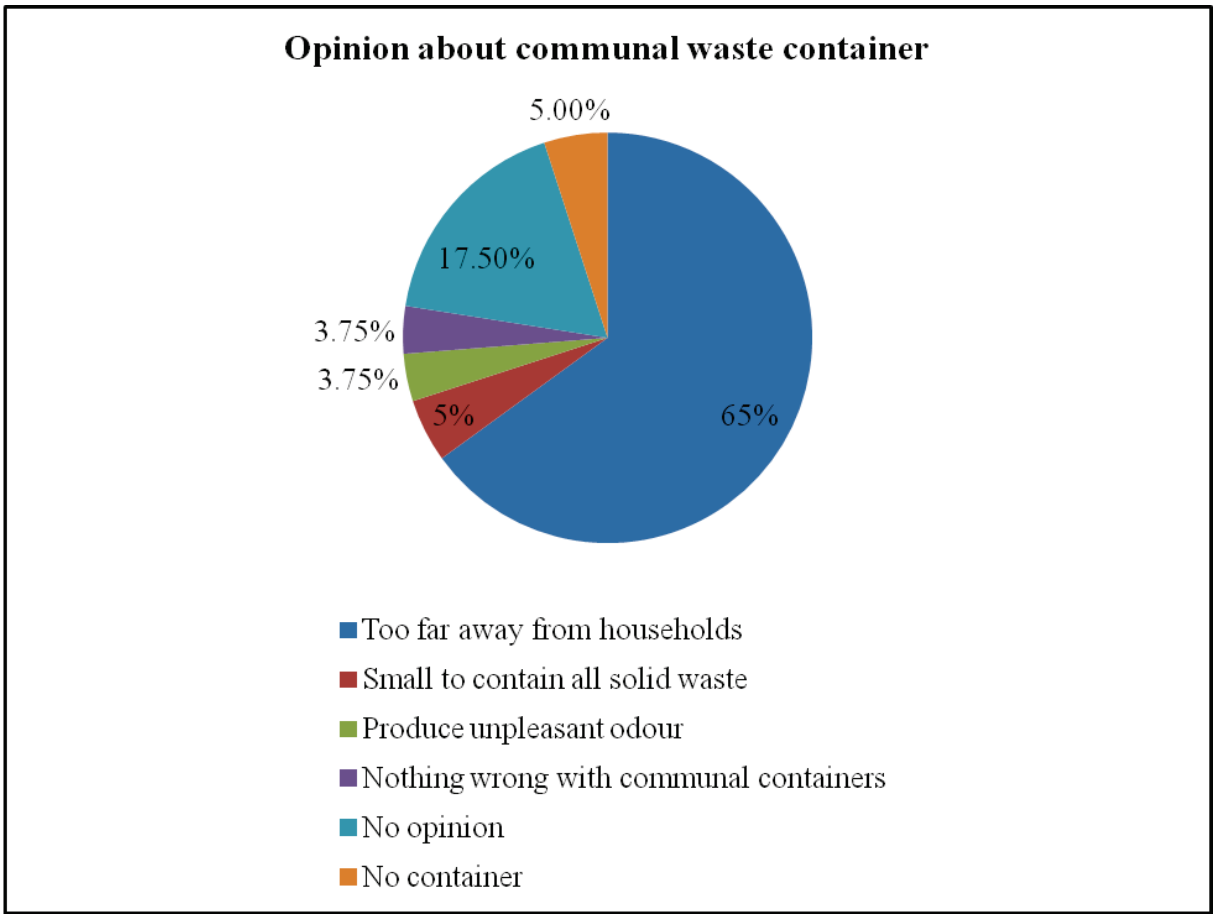


Figure 5.4.4 Public concern about communal waste container

A vast majority of respondents (65%) indicated that containers were far away from their homes, 5% noted that communal containers were too small, 3.75% were dissatisfied, complaining that containers produced unpleasant odours and aesthetically unappealing. 1.25%

saw nothing wrong with containers, 5% had no access to containers and 17.5% were unaware of the existence of communal containers. The number of communal containers in Buea were few and far away from most homes thus reluctance for homes to disposed of waste properly which most times is done by children. In some quarters, there were no containers and indigence attributed this neglect to the fact that the council did it intentionally because they were not loyal to the ruling political party. One could get a similar experience in other part of the nation because of people not being loyal to the ruling party.

Most rural non-metropolitan areas in Buea had no access to garbage collection service and people resorted to taking care of their waste through backyard burning and informal dumping. In the government residential area (GRA) also considered as senior service quarter, there weren't communal containers and many had no knowledge of it. In this area largely made up of single fenced apartment with enough backyard space, pit dumping is the obvious method of waste disposal.

It was noticed that people living closest to communal containers dumped all of their household garbage into it. In some cases, people living furthest away would separate out non-burnable materials, carried it to communal container and burned the rest. According to others being interviewed, garbage disposal activities included burning, burning, throwing waste in the bush and composting. Collection of communal containers was done from Monday to Friday, an average of four containers were disposed of per day.

Collection of solid waste is the most costly part of waste management and proper collection system design can reduce the cost significantly. According to EPA, (1989)[42] collection system will be operated either by the public or by municipalities and corporations. Collection frequency is based on the cost as well as requirements of the locality. When appropriate containers are used, it saves energy and labour, increases the speed of collection and reduces crew size. It is of great importance that containers should be functional to the type of materials and the collection vehicles used. The communal container used in Buea has been designed to fit the truck mounted loading mechanisms. These containers require mechanized handling because they are large and heavy. Access to storage location by waste collecting crew or vehicle is a very important consideration.

[42] Solid waste management: General Aspects. http://www.newagepublishers.com/samplechapter/001164.pdf Accessed 18.3.12

The size of the collection screw in Buea is small which is largely due to the limited number and small size of the collection vehicles. The use of communal containers is highly depended on the local practice, culture and the attitude of the people towards the wastes Communal containers. For areas with high waste generation capacity such as commercial centers, business establishment and vegetable markets, communal.

A frequent reoccurring problem is the fact that people throw their garbage next to the communal container or bin, causing unhygienic situation. After a close observation of the manner in which dispose of waste in the container, I was made to understand by one boy who came with garbage and through it next to communal container that the design was too high for children to dump waste inside. Mostly children are assigned by parents to take waste to Communal containers. Employing a guard to keep the communal bins and surroundings tidy will only place financial burden a council with already limited finances.

It is worth noting that the type and capacity of containers used depend on the characteristics and types of solid waste to be collected, the type of collection system in use, the collection frequency, and the space available for the placement of the containers.

On-site storage container could be temporal or permanent[43].

-**Temporal**: This container could disintegrate easily causing injury to waste collectors. Examples are; paper bags, plastic containers and bags, cardboard boxes, wooden boxes.

-**Permanent:** Modern waste collection requires the use of permanent on-site waste storage containers that are adapted to the loading and unloading mechanism of collecting vehicle and the capacity of permanent waste container depends on the volume of waste anticipated.

Likewise, the location of waste container depends on the type of residence or commercial or industrial facility, and available space. At the time this research was conducted, communual containers were placed at the following locations: (a) Check Point (b) Sosoliso (c) University of Buea junction (d) Clerks Quarters (e) Long Street (f) Soppo market (g) Presbyterian Comprehensive Secondary School (PCSS).

[43] Babanawo, R. (2006).

It is worth noting that the container placed at the University Junction had to be removed due to pressure from the university. Collection of waste was irregular and waste and aesthetic attraction was poor.

5.2.5 Public awareness of type of waste reused by household

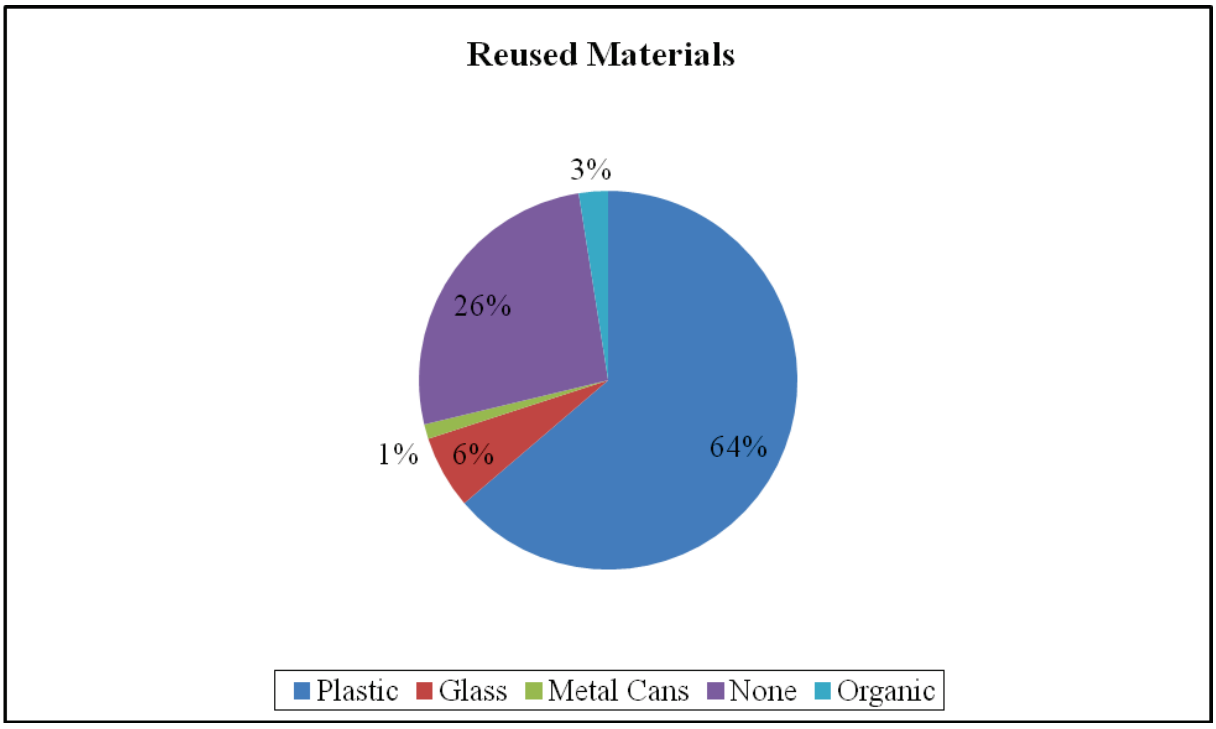


Figure 5.4.5 Public awareness of type of waste reused by household

6% of sampled population indicated that they reuse glass bottles, 64% stated that they reuse plastic bottles, light-weight polythene containers, 3% reuse compostable, 1% metal cans and 26% others. The high amounts of plastic waste are an indication that the contribution of plastics for packaging in the retail sector is high. This also shows a paradigm shift from the traditional method of packaging using wet or dry leaves to a more western lifestyle. Plastic has advantages over other materials i.e. it is cheap and light to handle. The only challenge handling plastics especially light-weight polythene in open market places is that improper

disposal has led to the littering of plastics on farm lands by wind. This has resulted to poor soil quality in Buea and most cities in Cameroon.

It is worth noting that e-wastes are hardly seen in waste containers. A greater part of the 26% of other reused materials would likely be waste electronics, much of which ends up in electronic repair shops. It is obvious that changing lifestyle is reflecting in a change in waste composition and reused material. Because of urbanization that has come with huge developments, cultural methods of packaging and storage is being destroyed i.e. short of traditional materials/plants.

5.2.6 Public concern regarding safe disposal of waste to the environment

In Buea, residents of neighborhoods have a sense of responsibility for their home and immediate environment but consider pulic places such as streets and drain the responsibility of the council.

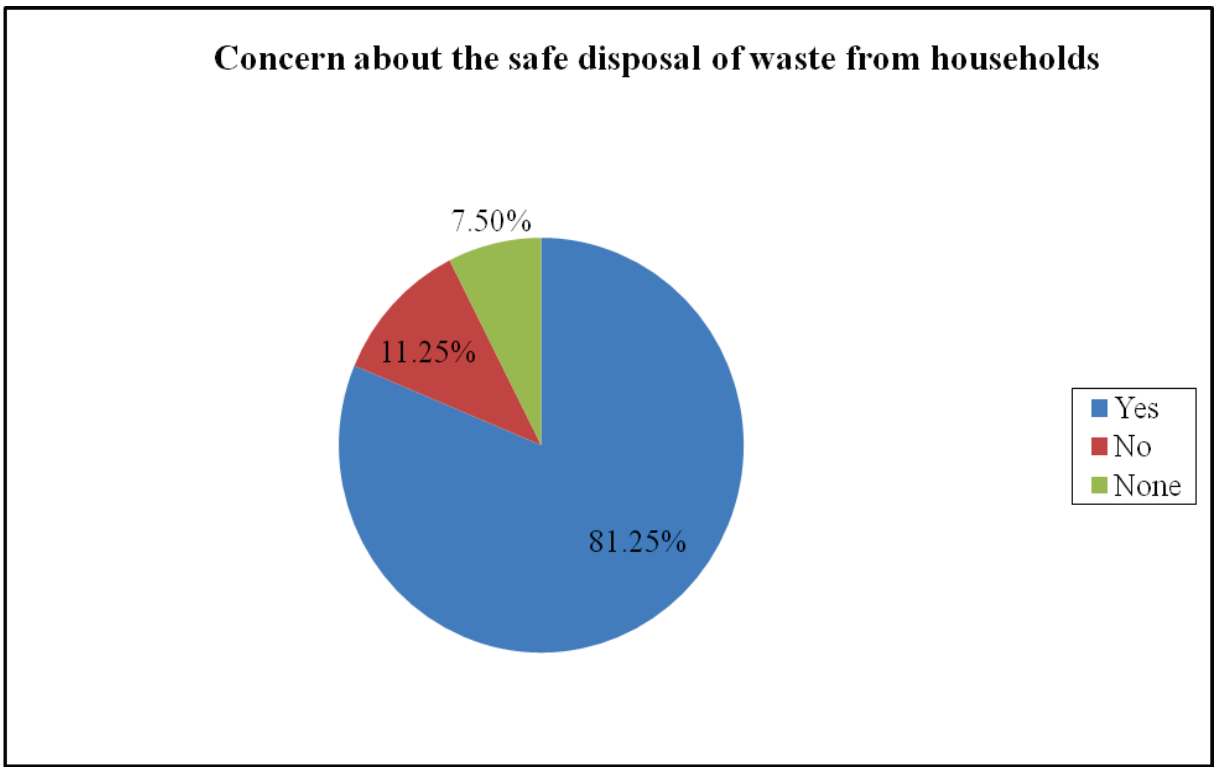


Figure 5.4.6 Public concern regarding safe disposal of waste to the environment

According to findings, 81.25% acknowledged the fact that they are concerned about safe disposal of waste to the environment,.11.25% had no concern about safe disposal of waste and

7.5% were unsure. The vast majority (81.25%) shows the level of environmental awareness (consciousness).

This high environmental consciousness is evidence that people have a sense of responsibility for their home and immediate environment. The mindset that it is the responsibility of the Council to keep public places clean has negative consequences for the cleanliness of public places in the city. The irony of the case of Buea is that the high concern about safe disposal of waste from households has not been effectively translated into action. However, once a month there keep Buea clean programme which has been so effective especially on the part of those living close to Buea main road. This programme runs from morning to mid day and all business premises are not supposed to operation. What makes this programme so effective is that there is penalty for anyone who goes against it.

5.2.7 Willingness to contribute to proper waste management

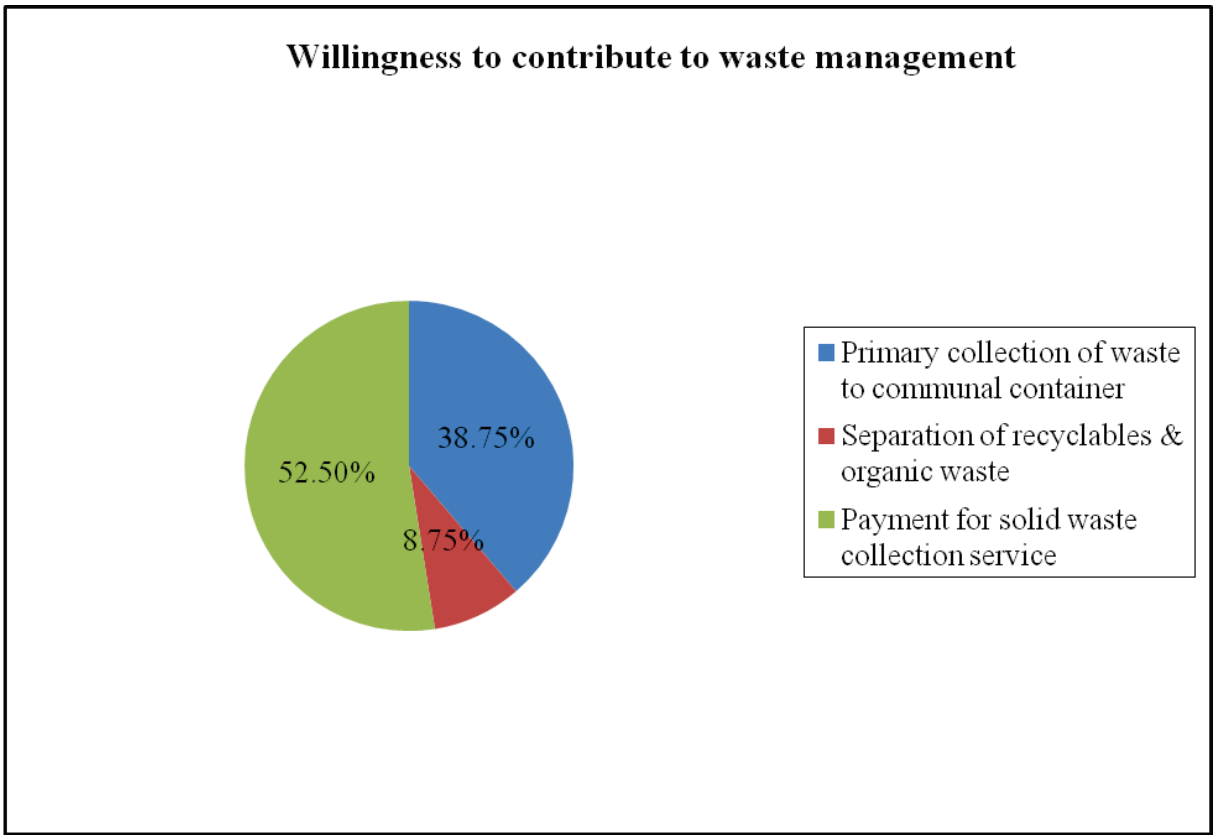


Figure 5.4.7 Willingness to contribute to proper waste management

An important issue to explore is the communities willingness to contribute to waste management. The willingness to pay and afford for an improved SWM service was so important and the results showed a very positive relation based on the income level and the fees amount the local communities are willing to pay. The local community's willingness to pay for an improved SWM system was so overwhelming.

The willingness to contribute especially in terms of payment is a very good working measure for analysing public attitude towards solid waste management.

38.75% of respondents acknowledged the willingness to contribute by transporting their garbage to the communal container, 52.5% majority indicated willingness to contribute by paying an amount agreed upon by the community for solid waste collection services, 8.75% indicated their contribution to separate recyclables and organic waste.

The willingness to contribute especially in terms of payment is a very good working measure for analysing public attitude towards solid waste management.

Although the Council attributes inefficient management of waste to limited financial resources, the results of this research shows that the populace would prefer to pay for waste management services than live in a dirty environment. This is also a call for private individuals and NGOs to indulge in door to door primary collection services which the council cannot provide.

5.2.8 Public rating of the provision of solid waste management services by the Council

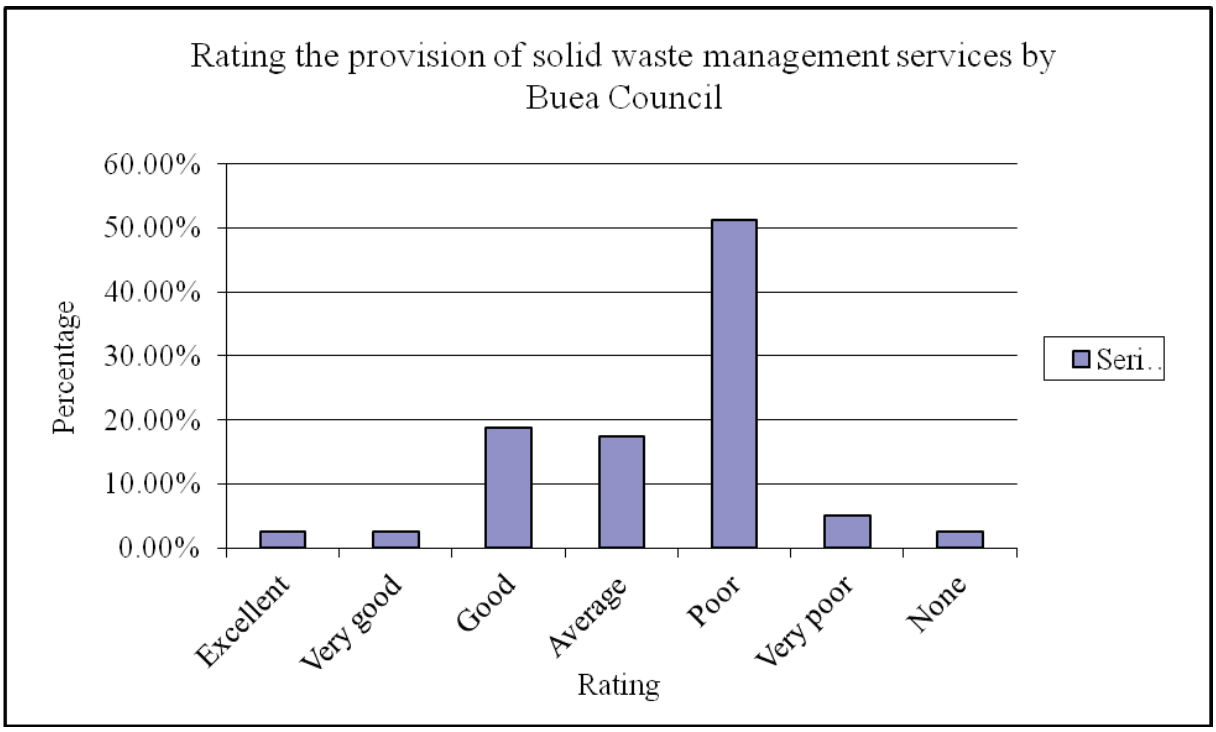


Figure 5.4.8 Public rating of the provision of solid waste management services by the Council

Respondents rated the council as follows; excellent (2.5%), very good (2.5%), good (18.75%), average (17.5%), poor (51.25%), Very poor (5%), neutral (2.5%).The poor rating is evidence that Buea council lack the expertise and resources for proper municipal solid waste management. Only one truck to collect waste in a fast growing city of 200.000 inhabitants and most times, lack of fuel and equipment to get the job done hampers effective service. This ineffectiveness leads to the dumping of waste in drainage gullies, streams, open lots and fields. These unsanitary conditions are greatly felt by poor metropolitan communities located next to garbage-filled gullies and official council dumping sites.

The lack of trust in the local government influences on citizen and household solid waste management behavior is low. This level of trust is an indirect influence due to its relationship with the central government.

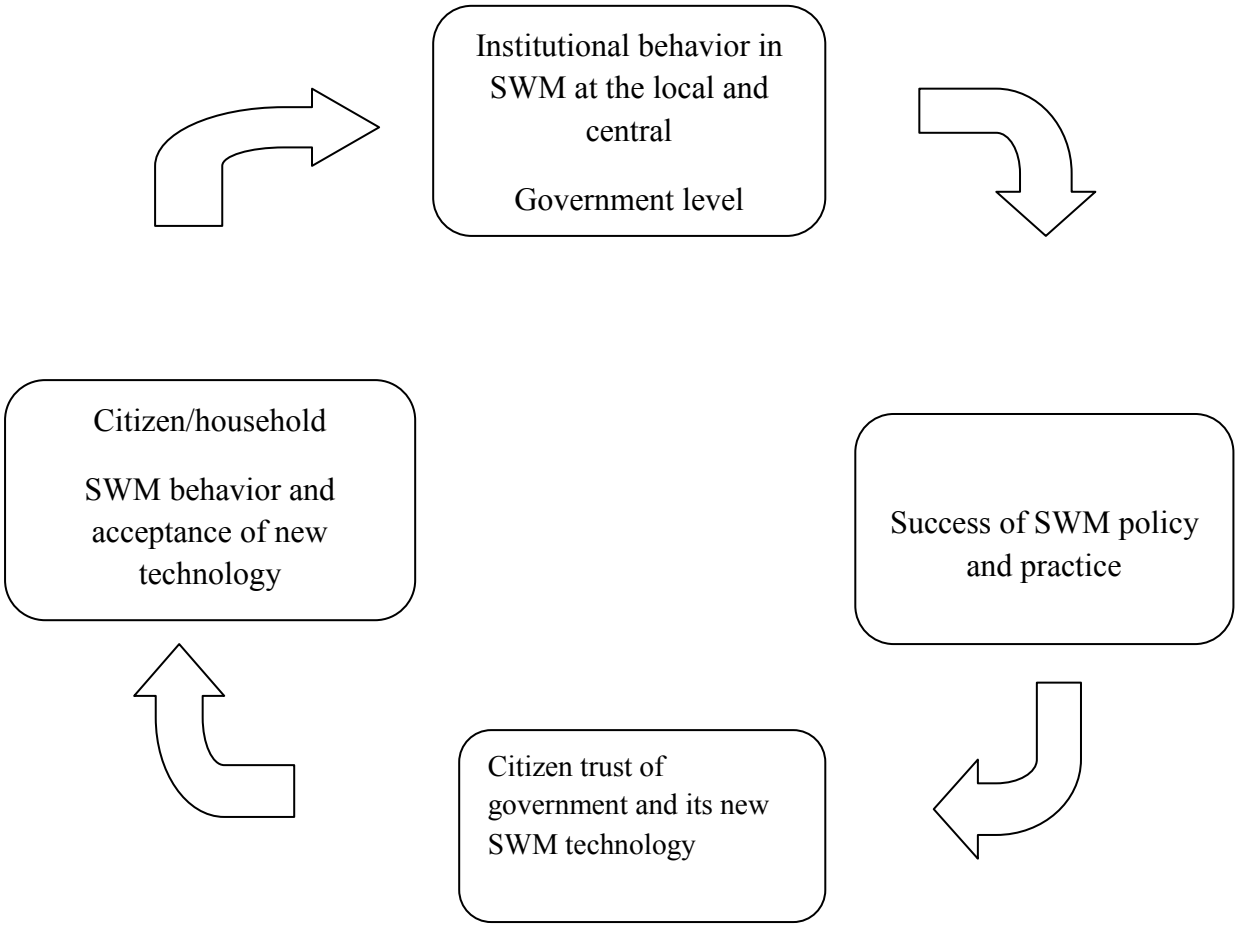


Figure 5.5 Institutional behavior/relationship in SWM at the local and central government level (Ruby P, 1980)

This calls for privatization of waste management sector in Buea like in neighboring cities such as Limbe and Douala where a hygiene and sanitation company (HYSACAM) operates. It also calls for government to subsidize local councils especially on waste management issues.

5.3 Focus group discussion

5.3.1 Gender Dimension: CLEAR Framework

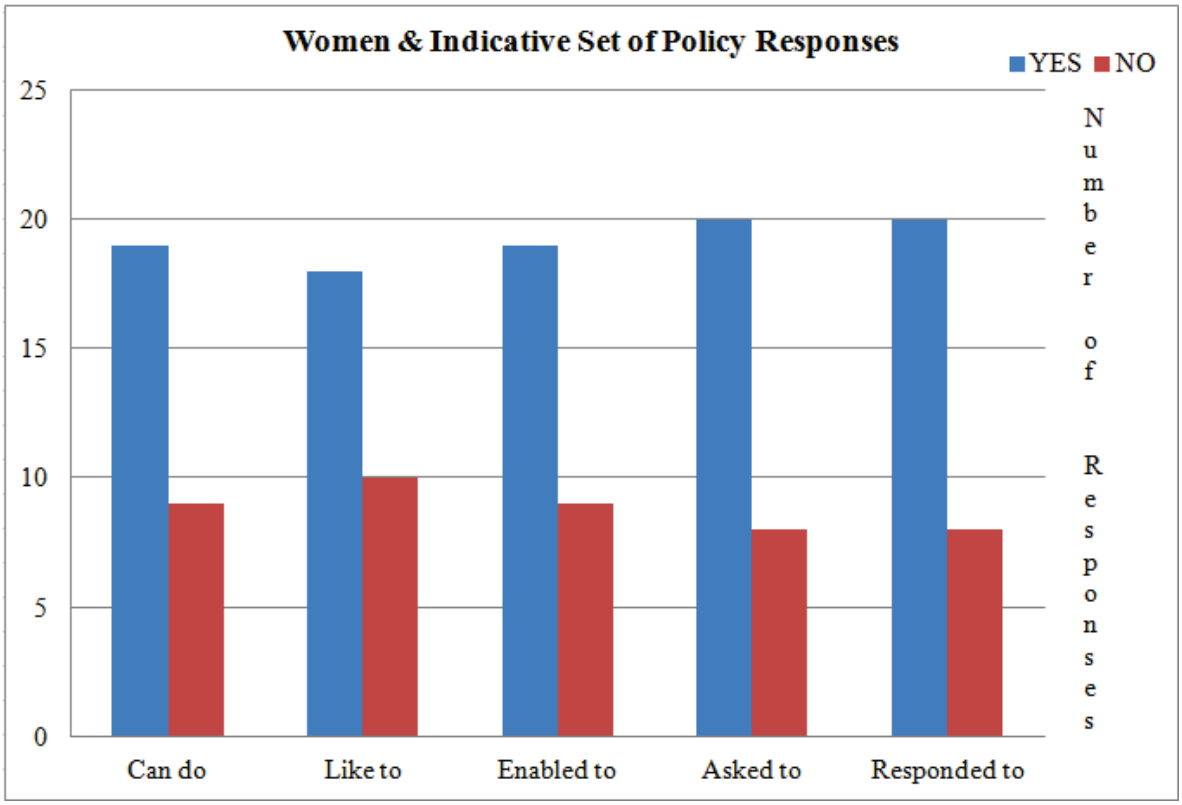


Figure 5.6 Women and Indicative Set of Policy Responses

The role of women in waste management and promotion of sustainable development is so pivotal. It is quite evident that they are directly concerned with waste management at home. Despite the overwehlming response, integrating gender concerns and perspectives in policies and programmes for sustainable development has not been accepted, let alone implemented especially in most developing countries. Even though some women have been included as stakeholders in sanitation department in the council and hospitals, they are still often treated as a vulnerable group. This is due to the fact that women's de facto rights of access to natural resources and land in most local communities are being hindered as a result of customary practices of the people.In most cases when women are involved, their responsbilite in waste management measures are often limited to home and community.

From the outcome of CLEAR framewok, if women are provided with the opportunity for participation and are mobilized through pubic agencies and civic channels, they will render effective waste management services. Women will gain experience in decision making and in managing local development activities if they were involved in minor projects.The outcome will be opened mindedness to participate in new political structures which will serve as a means to reduce social tensions and promote unity.

Where women do gain control of income, it is clear that they will likely use it for basic family needs and sponsorhip of children to school.This is common place in most rural communities like Buea where women faint for their household. The truth is that , it has direct or indirect impacts on poverty reduction at household and community levels.This has been proven right in the case studies women-run waste mangement in senegal and KAWWS, Karachi-Pakistan. In both cases, women took responsibilities upon themselves rose up to the challege because counsil was not able to meet the need of socisty.. Their successes is a prove that we Can Do if the opportunity is given.

5.3.2 Women rating of Buea Council's ability to management waste

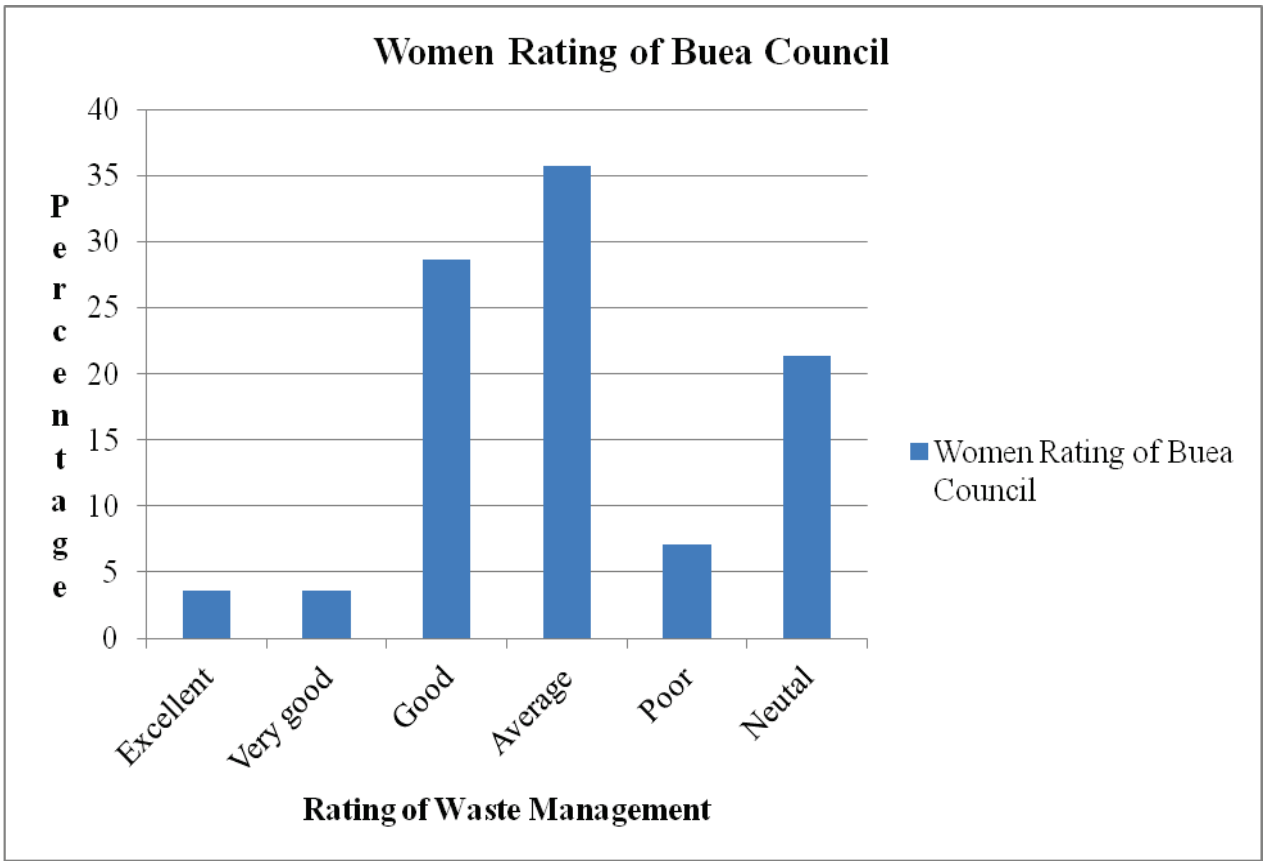


Figure 5.7 Women Rating of Buea Council

With the poor rating by the general public of Buea and an average rating by most women, it is a confirmation that the council has a long way to go regarding waste mangement. However, it is a clarion call for women to rise to the challenge like other women did in Pakistan and Senegal. However, it is an evidence that the Top-down approach over the years has proven not to be effective and efficient.

5.4 SPOT analysis and Social enterprising for Buea

Buea is a multicultural city that is fast embrassing a more western lifestyle. Bringing the people together is a major challenge but the benefits of a clean environment is a common ground. In order to pursue a plan or action in Buea, SPOT analysis[44] serves as a strategic

[44] The grove consultants international

planning tool that can be used to help people make informed decisions. According to the grove consultants international (1996), this tool identifies Strengths, Problems, Opportunities and Threats.

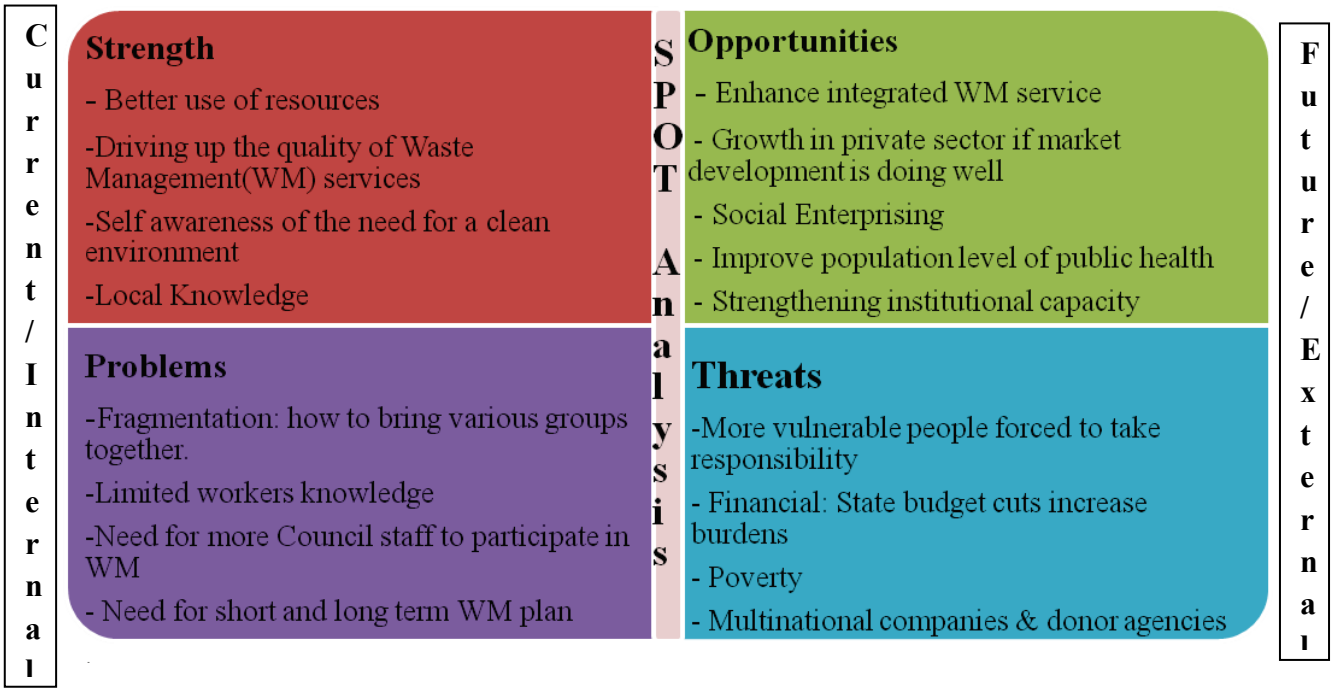


Figure 5.8 SPOT analysis for Buea

Socal interprising in Buea will maintain a strong sense of community cohesion and purpose. Reasons being that it will not only enhance small scale investments in solving waste management problems but a wide range of community challenges.

Social enterprising is a huge benefit applying the Bottom-Up approach in Buea. It involves the generation of income by the locals themselves through the selling of waste materials in order to achieve their social, cultural and environmental objectives leading to a healthy communities.

www.ode.state.or.us/.../grants/.../**spot_analysis**-1.ppt [03.06.13]

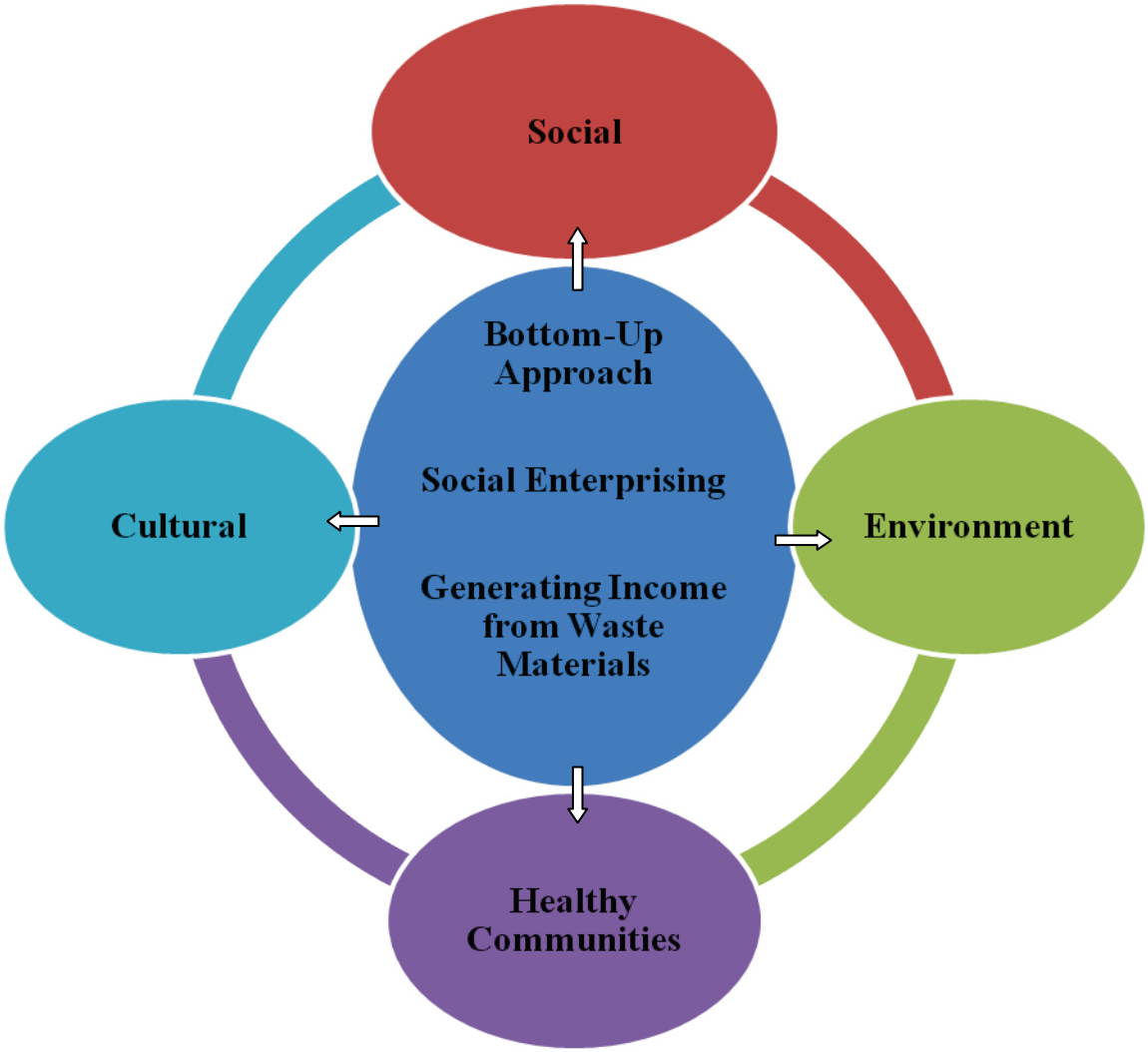


Figure 5.9 Promoting social enterprising in Buea through Bottom-Up

Social enterprises are businesses whose primary purpose is the common good. According to Social Enterprise Alliance[45] (2013), they produce direct and measurable public benefits and serve four public aims:

- Social justice – Offering a chance to those most in need.
- Economic opportunity – It ensures job creation in communities in need of economic renewal and improves the pool of human capital.

[45] Social Enterprise Alliance, 2013. The Case for Social Enterprise Alliance https://www.se-alliance.org/what-is-social-enterprise

- Public safety – It disrupts the cycles of poverty, and homelessness thus making the community in which it operates safer.
- It provides a pathway to economic self-sufficiency for those it employs.

This will have great impact on the cultural perspectives of the locals.

- Seeing waste as cash thus locals will be fully involved in waste collection and trading.
- Non reliance solely on the council for waste management services.
- Avoidance of NIMBY, "not in my back yard". Culturally, getting waste out of home and dumping on any available piece of land is considered as waste management.

From waste characterization in Buea, it is evident that organic waste composition is above 70%. Considering the fact that the agricultural sector constitutes 19.7 %of the nation's GDP - (CIA, 2012), composting will be a lucrative business thus increasing the efficiency in agriculture. The enterprising of plastics and metals which are also significant in the waste stream of Buea is such a huge benefit of the Bottom-Up approach. Unlike the Top-down approach, the Bottom-up understands the way of life of the locals and would improve on their standard of living, lifestyle and education.

CHAPTER 6 : Municipal Solid Waste Management in Buea

6.1 Institutional Framework

In Cameroon, a number of ministries share the central responsibility of MSWM. While some ministries are concerned with organizational and financial matters, others are responsible for technical operations. The Ministry of Environment and Nature Protection is responsible for the implementation of MSW activities. Her role is to Collaborates with other agencies (private sector or NGOs) to define measures for the rational management of natural resources; Effective control of pollution in the field; Specifies the criteria (project specific) and supervises environmental impact assessments. The Ministry of Finance is responsible for approving budget allocations for operational cost. According to Manga et. al. 2007, a steering committee comprising six ministries coordinate the implementation of issues related to MSW.

Table 6.1 Roles and responsibilities of key ministerial departments related to waste management Cameroon

Ministerial department	Key responsibilities related to waste management in Cameroon	Statutory Order
Ministry of Territorial Administration and Decentralization	Follow-up and implement regulations for organizations and functioning of Councils; Oversees the execution of the budget of the government' council support fund(FEICOM); Restoration of hygiene and public sanitation; supervises Urban Councils which are responsible for follow-up and control-industrial waste management, management of all public spaces and infrastructure; Sweeping of streets, collection ,	Circular letter No.0040/LC/MINAT/DCTD of 04/04/00, Order No. 00072/MINAT/MINVILLE of 21/05/00, Law No. 714/23 of 5/12/74, Law no.2004/18 of 22/07/04

	transportation and treatment of household waste	
Ministry of Mines, Industries and Technological Development(MINMITD)	Develop strategies for industrial development and the control of Classified and commercial installations for pollution, security, hygiene and industrial nuisance; Define norms for industrial pollution; List of dangerous, obnoxious and polluting facilities in order to inform the public; Develops regulations governing installation and exploitation of facilities classified as dangerous, obnoxious and polluting	Decree No. 99/818/PM of 9/11/99, Order No. 13/MINME/DMG/SL of 19/04/77, 02/MINMEE/DMG/SDAMI Of 4/01/9
Ministry of Economy and Finance(MINEFI)	Financial control of organizations benefiting from supplementary budgets and autonomous public establishments, i.e. Councils; Responsible for managing the Finance Law as enacted by Parliament	Constitution Decree No. 2004/320 of 08/12/04
Ministry of Urban Development and Housing(MINDUH)	Develops and implement Urban restructuring, management strategies, sanitation and drainage; Defines and enforces norms of hygiene/sanitation, collection and/or treatment of household waste; Liaises with international agencies for urban development	Order No. 00072/MINAT/MINVILL of 21/05/00

Ministry of Environment and Nature Protection(MINENP)	Collaborates with other agencies to define measures for the rational management of natural resources; Effective control of investigation and pollution in the field; Specifies the criteria(project specific) and supervises environmental impact assessments	Decree No. 2005/0577/PM of 23/02/05 7), Order No. 006/MINEP of 08/03/05
Ministry of Public Health(MINPH)	Creates Hygiene and Sanitation Units in Councils; Renders technical support to the Hygiene and Sanitation Units Councils, Proposes norms for collection, transportation and treatment of industrial, domestic waste and emptying of septic tanks; Designs and implements public education campaigns on hygiene and sanitation.	Order No. D67/NS/NN/ST/SG/BMPHP/NNPA of 11/08/87, Circular letter No. D69/N6/DMHK/SHPA of August 1980

Source: Manga et. al, 2007

6.2 Legal Framework

Table 6.2 Legal framework for WM in Cameroon

Legislation	Key elements related to waste management in Cameroon	Statutory Order
Law relating to Environmental Management(No.96/12 of 5/08 1996)	National Environmental Management Plan related to the protection of the atmosphere, marine and continental waters, soils, sub soils and human settlements; Regulates installations that pose dangers to public; Stipulates	Decree No. 2005/0577/PM of 23/02/05, Order No. 006/MINEP of 08/03/05

	modalities for the conduct of Environmental Impact Assessments(EIA) and categories of operations subject to EIA; Specifies air emission and waste water discharge standards; Set conditions for issuing authorizations for allotment and management of land for uses, i.e. industrial, urban etc; Prescriptions relating to waste elimination by persons producing or treating waste; Stipulates the terms of reference for the supervision of municipal dumps by the competent authorities	
National Environmental Management Plan	Five year amendable plan; set up environmental information system; Preparation of bi-annual reports on the state of the environment in Cameroon, e.g. identifying problems arising from urban pollution and devising suitable micro-projects to mitigate the problems	-
Law relating to the installation of Classified establishment(Law No. 98/15 of 14/07/98)	Stipulates two types of Classified establishments (Class 1 and Class 11).Dump sites are classified as Class II establishments for which operations and management must followed prescribed guidance. It sets out the regulations governing the installation and exploitation of facilities classified dangerous, obnoxious and polluting;	Decree No.99/818/PM of 9/11/99, Order No. 13/MINMEE/DMG/SL of 19/04/77, 02/MINMEE/DMG/SDAMIC of 04/01/99

National Water Code (Law No. 98/005/of 14/04/98)	Provides framework for the exploitation of water resources including waste disposal, Specifies modalities for the protection of surface and groundwater from pollution (including from dump sites).	Decree No. 2001/165/PM of 08/05/01
New Urban Strategy, 1999	Partnership among the state, local council and authorities and civil society in urban intervention in areas such as solid waste management.	-

Source: Manga et. al, 2007

It is worth noting that in Cameroon like other African countries, policies are well formulated, legal framework is well written and documented but there is always lack of political will to fulfill requirements on the part of the government and policy makers.

6.3 Functional Elements of MSWM in Buea

6.3.1 Municipal solid waste flow

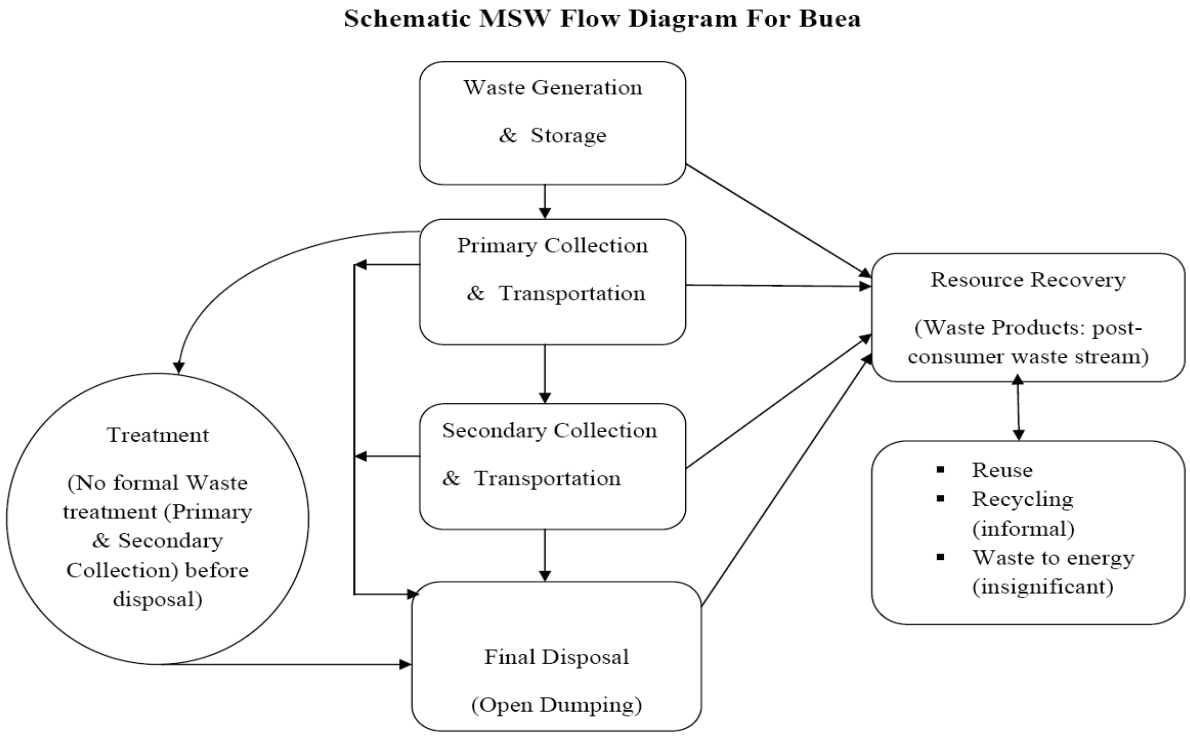


Figure 6.1 Schematic MSW Flow Diagram fo Buea

The flow of material in Buea is illustrated in the schematic diagram above. Emphasis is based on the fact that we do not consume materials but we merely use them and ultimately return them, most of the time in an altered state to the environment.Recylable materials may be extracted from the waste stream from the points of generation, transfer or disposal.

According to Vesilind et al.(2002), the production of useful goods for eventual use by the so called “consumers” requires an input of materials. These materials originate from one of three sources:

- Raw materials which are extracted from the surface of the earth and used for the manufacture of products;
- Scrap materials produced in the manaufacturing operation;
- Materials recovered after the product has been used.

The resulting processed goods are sold by users of the products who in turn have three options after use: (I) dispose of this material (II) to collect the material in sufficient quantities either to use it for energy production or to recycle it back into the industrial sector or (III) to reuse the material for the same or a different purpose without remanufacture. However, this is typical of a closed system with only one input and one out. It is worth noting that Buea and most rural communities and cities in developing countries have not yet attained this level of waste management because of lack of financial resourecs, technology and know how. For Buea, manufacturing is informal and basical at a local scale, insignificant informal recycling, neglegeable waste to energy recovery and final disposal in open dumping(uncontrolled landfill).

6.3.2 Collection & Transportation

The city of Buea is located at the foot of Mount Fako with a warm and humid tropical climate. As an old colonial town and an academic center, the economic landscape is dominated by tourism, Banking, Hotel services and flourishing micro and medium size interprises. As population is on a geometric increase, lifestyles are changing, so there is increasing quantity of waste. With only 16 member work force that operate with lack of skills, waste management becomes a great challenge.

Collection of waste is done from door to door by informal collectors in some quarters on monetary basis about 500-1000 FCFA per week of collection. Collection by the Council(communal containers) is done three times weekly especially in Molyko that is densely populated and worst hit area.

The basic means of transportation used by the council and private(informal) waste collectors are; trucks, tractors and trycicles.

Truck **Tractor** **Tricycle**

Figure 6.2 Means of waste collection and transportation in Buea

The Council had only one truck used for waste collection in the entire city of two hundred thousand inhabitants. Waste management service has been a challenge to the Counil work force for the following reasons:

- Most workers were of age (elderly)
- Workers suffered from inferiority complex because waste collection and transportation is considered a menial job ”dirty job” which even graduate from department of Environmenatl Science of the University of Buea will not do.
- Workers don’t work freemindedly : provision of work tools like nose mask, gloves, rainboots and raincoats was not regular.
- Sometimes workers had to start work late because of delay by authorities responsible to disburse money for fuel.
- No motivation due to lack of incentives. To make the matter worse, at times improper disposal of waste by city dwellers around communal containers will cause a work force of two workers per trip to spend hours filling container with waste dumped on the ground.

Waste is transport to uncontrolled dumpsite at Musaka near Muea town. There is no transfer station in Buea. It is worth mensioning that due to limited and bad road conditions to many

quarters in Buea, the operation of HYSACAM in Buea will improve waste collection but their services will be hampered. Effective waste collection service goods with good road infrastructure.

6.3.3 Waste Disposal

In Buea, final disposal of waste is done at different levels i.e. after primary or secondary collection. It is worth noting that the Council could only collect about 30% of total waste generated in Buea municipality. The following methods of waste disposal could be indentified during field survey:

Table 6.3 Existing Methods of Waste Disposal in Buea

Sources	Methods
Households	- Dump in Communal Container, road site, streams, pit and burning.
Commercial establishments	- Dump on road side, drainage, and in Communal Container.
Churches and Marriage halls	- Dump in Communal Container
Markets	- Dump in Communal Container, market premises and Burning
Hospitals/Clinics/Nursing homes	- Burning(local incinerators), Dump around hospital premises
Schools	- Burning and pit dumping
Hotels and Restaurants	- Burning of recyclables for fuel, Dump in Communal and roadside.

It is worth noting that many people resort to waste burning during dry season as the easiest and fastest means of managing waste. This is evident by the rising smoke at certain locations especial Mile 17 hill along the highway causing poor visibility.

6.3.4 Waste Reduction and Recovery

There are three ways in waste reduction can be achieved: (I) reducing the amount of material used per product without sacrificing the utility of that product, (II) increasing the lifetime of a product, and/or (3) eliminating the need for the product. It is possible for consumers to buy fewer manufactured goods.

Vesilind et al. (2002) sugest that inorder to achieve low use of raw materials and waste generation, it is possible to decrease the amount of manufactured goods. First, this reduction will mean a redesign of products in such a way as to use less material.This can be done by government of Cameroon legislating a low rate of material use by placing taxes on excessive packaging, initiating a packaging charge (1000 cfa per kg of packaging), requiring mandatory longer life of manaufacture products, and other options.

Second, another means of reducing waste is to reuse the products. This is done so easily , such as paper bags for taking out the garbage, cans to hold nails, cans are also used b locals to measure goods for sale like groudnuts, maize, gari, refilling soda and bottles for selling red oil, kerozene etc. Also, items can be repaired instead of discarding it and buying a replacemet is a typical example of the tradeoff between a lobour-intensive society and a consumer-based society.

The third means of reducing the waste destined for disposal is to separate out materials that have some economic value, collect this separately and use them as a source of raw materials.This process is termed recycling and involves te active participation of the product user.

The fourth means is to process the solid waste so as to recover useful material from the mixed waste.Waste processing is not practiced in Buea at the moment even with the advent of the waste management company HYSACAM .Recovery can also include the recovery of energy from the solid waste. A waste to energy plant or a landfill gas recovery system can recover the energy value of the solid waste through a transformation process.

6.3.5 Dumpsites

In Buea, there is usually a problem when a place is declared as a dumpsite. From a dumpsite visitation carried out on the 15th of April 2010, five main dumpsites were identified.This dumpsite visitation/investigation was done in collaboration with Council workers responsible for the collection of waste in communal containers and final disposal. The following sites were identified:

Table 6.4 Dumpsites in Buea

Illegal		**Official**			
Buea town	Mile 17 hill	Behind Presidency	Street 3 Great Soppo	Mile 16	Musaka

NB: Musaka is the present dumpsite.

A important component of integrated WM is safe and reliable disposal of MSW and residues. In African countries, open dumping is common place. Very little is done about it considering the fact that waste is disposed in manner that does not protect the environment. According to Rushbrook (1999), about three-quarters of the countries and territories around the world use open dumping method of disposal of MSW. In Buea the siting of municipal dump sites and the management of old ones is a cause for concern. Although most people are not ignorant of the health ricks associated with dumping of waste , some possible reasons why this practice is so prevalent are:

- Lack of political will to protect and improve public health and the environment.
- Acceptance of the status quo due to lack of finances properly manage the waste.

During field survey at an old dumpsite in Great soppo Buea, in the process of a young boy dumping waste, a women who lived about 3m away from the heap shouted" Don't do that because ants will kill us here!". That is the plight of many. People in many neighbourhoods made us to understand that by concerted action, the had to chase the Council from using their land as a dumpsite.

Buea – Present – Dumpsite

Limbe – Present - Dumpsite

Limbe – Waste Disposal – Truck

Buea – Waste Disposal - Truck

Figure 6.3 Area view of dumpsites in Buea and Limbe

Although waste generated in the city is disposed of in open dumping in peripheral areas, the environmental effects are ernomous.Most often, sites are unhygienic and a nuisance to the environment surrounding residential areas. Several residents have complained of environmental pollution caused by solid waste which is long-term and may even be permanent.

6.4 Clean Development Mechanism (CDM)

The protection of Climate is a global challenge and this burden has to be borne by developed countries who have contributed the most to global warming that is measured by per capita emissions. According the Kyoto protocol of 1997, industrialised countries(Annex 1) have to reduce their emissions[46] in the period of 2008 to 2012 by 5% compared to the reference year of 1990. With this, each country has a different target. The most effective way the international community attempts to achieve climate protection at a reduced cost is by putting in place an innovative mechanism(CDM) that enhances cooperation in climate protection between developing countries and industrialized countries.

According to a GTZ[47] report, CDM is a project based mechanism and targets two aspects: (1) supporting industrialized countries to reach their emission targets (2) simultaneously, developing countries are supported in sustainable development.It is worth noting that CDM is one of the three mechanisms to achieve emission reduction. The others are Emission trading known as the carbon market and Joint implementation(JI).

Methane generated at solid waste landfill sites contributes approximately 3-4% annual global anthrpogenic greenhouse gas (GHG) emissions Jeon et al. (2007). Emission reduction from waste management in Africa can be achieved through the capturing and combustion of landfill gas, with energy recovery where it is practical. However, it is necessary that material composting and recycling which is higher up the waste hierarchy should provide more emission reductions than collection and combustion of landfill gas with energy use like electricity generation.

According to Couth and Trios (2010) the average organic content for urban municipal SW in Africa is around 56% and its degradation is a major contributor to greenhouse gas emissions[48]. The contribution of methane produced at solid waste landfill to the annual global anthropogenic green-house gas emission is approximately 3-4%(Jeon et al.2007).

[46] The emissions covered by the Protocol - carbon dioxide, methane and nitrous oxide, along with the release of longlived hydrofluorocarbons and sulphur hexafluoride.
[47] Project-based cooperation between industrialized and developing countries to protect the climate http://www.gtz.de/de/dokumente/en-climate-cdm-info.pdf, [18.04.12]

CHARPTER 7: Conclusion & Recommendations

7.1 Conclusion

From the analysis of many case studies and research findings in Buea, it is evident that top-down approaches in waste management cannot be successful without sufficient community engagement and sense of ownership. A greater community involvement does not only minimize the chances of conflicts that have been a setback to major environmental projects but enhances environmental monitoring, management and capacity building of local community members. Some of the huge projects funded by Developed nations, international organizations and the governments of some African countries ignored the concerns and needs of local citizens and even the negative environmental impact of these large-scale problems. The missing link has always been the lack of indigenous knowledge. I realized from field work that community members were willing to give knowledge when I engaged them in a participatory approach through focus group meetings and home discussions. This indigenous knowledge most often minimized by experts is vital for the sustainability of community projects. Involving community members is often a slow process but the outcome is always far-reaching.

The results show a strong concern for a clean environment and the belief that capacity building, access to and dissemination of waste management information, awareness campaign and the protection of community concerns by allowing greater access to the decisions concerning planning, operation and the management facilities is so vital. Citizens' participation and awareness creation is so vital to take the massage to grass root levels. From research, it is clear that where a reliable service can be guaranteed communities are willing to pay for it. MW collection services are more effective when they work in collaboration with community led primary collection from households. It is worth mentioning that locals especially those who offer or forfeit landed properties for waste disposal are more reactive than proactive.

Buea has a huge resource potential of waste streams. Not all waste from households, market places and institutions are disposed of in the communal container. From findings, it obvious that most of the waste in the city is generated by households. The avoidance of up to 40% of

waste by recycling and recovery is justified by the fact that there is high reuse of materials, 64% of such are plastics although recycling is informal.

For Bottom-Up approach to sustaining SWM to thrive in African countries and take effective root, governments and municipalities must comply with the following:

- Must recognize the role of the informal sector in recycling and involve the locals in the search for solutions to the main problems related to trash collection, recycling and dumpsite selection and management.
- Promotion of complementary alternatives such as community initiatives to remove refuse while earning income for the poor.
- Developed nations and international organizations providing funds for major MSW projects must recognize the environmental side effects of large scale projects, the need and concerns of the locals.
- Implementing an integrated system using appropriate technology is an impetus to ensuring that MSW problems are tackled in a manner which provides for the greatest common benefit.
- Imparting citizens with information and knowledgeable about a set topic so that effective participation could be achieved. This entails that citizens will have to take responsibility for the quality of their participation (showing interest and maximizing opportunities) and be accountable for the use of time and resources.
- There must be provision of appropriate protection(especially facilities to handle hazardous) for workers and the surrounding community by regulating market driven recycling and eliminating unhealthy practices as scavenging at landfills.
- The key driver towards increased efficiency in SWM should be the involvement of all stakeholders.
- There should be room for capacity building: technical training and a focus on more general environmental education.

- There should be a successful establishment of baseline levels of information from which more informed policy and WM decisions can be made.

- The government must play the pivotal role of a referee, not dictating but having the capacity to monitor performance and having the political will to enforce contractual or license agreement. This will eliminate unscrupulous practices and laissez faire attitude of any stakeholder.

Although Bottom-Up approach is time consuming, it is the most favourite approach for every rural community. However, it does not undermine the fact that the best implementation in some situations is some sort of a middle ground between authoritarian and the relaxed or laissez faire approach many governments take in regulating waste management.

7.2 Recommendation:

There are different ways of solving waste management problems in rural communities especially in developing countries. One of which include privatization. Two options for privatization strategies can be taken into consideration: Buea council would hand over waste management service to private entrepreneurs and pay them according to their services or the total service taken over by private firm including revenue collection and solid waste management. The first option has been considered by the Buea Council. While completing this research in May 2010, plans were on the way by the Council to sign a 5-year contract with the private contractor HYSACAM worth 2.8 billion FCFA. HYSACAM finally went operational in Sept. 2010. This move helps the Council to focus its attention on policy formulation, regulation and other support activities. The good news is that the council could only employ about 16 people to do the job but now over 70 residents of the Buea municipality are expected to benefit through employment with HYSACAM during the length of the agreement

Regionalization is one of the best ways some communities have developed to meet waste management challenges. EPA (1994) defines regionalization as a process whereby neighboring cities, towns, and counties pool resources to address local challenges. This means that rural and small communities will be able to accomplish together what is difficult to do

individually. Regionalization is so important in waste management because it is the function of the local government. Unlike Urban Councils, most local councils have limited resources (lower tax base) to solve complex waste management problems. When small communities with few resources work together, effective recycling programs[49], state-of-the-art landfills, and waste to energy facilities are within reach. Considering the fact that HYSACAM is presently managing waste in Buea and Limbe, regionalization will be the most appropriate strategy getting Tiko rural councils and neighbouring towns on board. Some of the advantages of regionalization will include:

-Greater economies of scale: communities bringing their resources (financial, administrative, personnel and equipment) together will accomplish projects too expensive for a single community.

-It will facilitate the cost-effectiveness of community recycling efforts. Communities having the opportunity to set a better price for their recyclables especially if they have large quantities.

-It enhances cooperative purchasing agreements among several municipalities which makes buying recyclables more cost effective.

-Increased financial support. It provides greater opportunities in obtaining financial resources for SWM planning and implementation activities. Governments will give priority to regional efforts than individual efforts.

-It increases flexibility and environmental improvement. With more resources and revenue, more opportunities are open to communities to develop strategies that meet their needs. Access to technologies will promote environmental protection for many municipalities.

HYSACAM, the leading waste collector and landfill operator in Central Africa including the cities of Limbe and Buea. With such a large quantity of waste generated annually in Buea, Limbe and neighbouring towns the impact of HYSACAM indulging in Regionalization and development of controlled landfills in the south west region will be far reaching. This will enhance **Certified Emission Reductions** (CERs), which will be generated by the capture and destruction of methane gas emitted by the decay of municipal waste from these landfills. The gains of such a scheme will be threefold: The gains of the CDM are threefold: (i) it reduces costs induced by the adaptation of industrialized countries to global warming; (ii) it promotes

[49] Including the marketing of recyclables and buying of goods with recycled content

the transfer of clean technologies to developing countries (i) It will create employment and generate income.

7.3 Need For Further Research

- Cost-effective approach for dumpsite rehabilitation in rural communities
- The economics of resource recovery in rural communities
- Identification of future options for solid waste management with respect SSWM

References

Arlosoroff, S. (1982). "WB/UNDP Integrated resource recovery project: Recycling of waste in developing countries." Inappropriate waste management for developing countries, edited by Kriton Curi. New York: Plenum Press, 1985

Arnold van de Klundert, Anschutz, J. (1999). Integrated Sustainable Waste Management: the selection of appropriate technologies and the design of sustainable systems is not(only) a technical issue
http://www.worldbank.org/urban/solid_wm/erm/Annexes/US%20Sizes/Annex%204B.3.pdf [Accessed on 10.3.12]

ACEPESA (1994). Project documentation pilot project Hatillo, 1994. Amed, R. (ed.) First APE international conference on recycling of solid waste. Case studies, future plans and strategies. Conferences proceedings. Karachi, Ghana, 1994

Amin, A.T.M.N., Sinha, M. A.H., MD. (editor) (2000). Community Based Solid Waste
Management: The Asian Experience. Paper and proceedings of the Regional Seminar on Community Based Solid Waste Management, Dhaka, Bangladesh.

Ackerman F (2005). Special feature on the environmentally sustainable City. International Review for Environmental Strategies, Vol. 5, No. 2, pp. 499-510. Institute for Global Environmental Strategies. http://ase.tufts.edu/gdae/Pubs/rp/Material_Flows05.pdf [Accessed Feb. 2012]

Andersen, Stephen O., K. Madhava Sarma, and Kristen Taddonio (2007). Technology transfer for the ozone layer: Lessons for Climate change. London: Earthscan.

Bonomo, L. and A. E. Higginson (1988). International Overview on Solid Waste Management (A Report from the International Solid Waste and Public Cleansing Association) Academic Press, London.

Baltic States (2001). Project "Developing new opportunities for municipal waste management in three Baltic States. The Regional Environmental Center for Central and Eastern Europe.

Blight, G.E. and Mbende, C.M. (1996). Some problems of waste management in developing countries. Journal of Solid Waste Technology and Management 23, no. 1, February 1996. Pp 19-27.

Badran, M.F., El-Haggar, S.M. (2006). Optimization of municipal solid waste management in Port Said – Egypt. Waste Management 26 (5), 534 - 545

Bartone, C., Leite, L., Triche, T. and Schertenleib, R. (1991). Private Sector Participation in Municipal Solid Waste Service: Experiences in Latin America. Waste Management and Research 9: 495-509.Bartone C. (1988). The Value in Wastes. Decade Watch. September: 3-4.

Bartone C. (2000). Strategies for Improving Municipal Solid Waste Management: Lessons from World Bank Lending and CWG Activities. Workshop on Planning for Sustainable and Integrated Solid Waste Management, Manila, 18-22 September 2000. Washington, DC: Urban Management Division, World Bank.

Bruce L.S. (2003). Public policy and public participation. Engaging citizens and community in the development of public policy. BLSmith Groupwork Inc.

BMU (2005). – Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. Waste Incineration – A Potential Danger? Bidding Farewell to Dioxin Spouting http://www.bmu.de/english/waste_management/downloads/doc/35950.php[Accessed May 2012]

Babanawo, R. (2006). Constraints to sustainable solid waste management in Ghana (Thesis-BTU) http://d-nb.info/984500952/34 [Accessed 25th June 2013]

Charles R. Rhyner et al. (1995). Waste management and resource recovery. Lewis Publishers, NY, USA

Cointreau-Levine, S (2000). PSP in municipal solid waste management, Part II : Guidance Note, St Gallen: SKAT, 2000, p.5

Cortinas de Nava C. (2001). Hacia un Mexico sin Basura. LVIII Legislatura, H. Congreso de la Union. Mexico.

CED (2003). Study of the attitude and perception of community towards solid waste management – Phase II.

Cointreau-Levine S., Cravioto, F.G. (2005). Finance for Solid Waste System in Developing Countries., http://siteresources.worldbank.org/INTUSWM/Resources/FinanceForSW.pdf [Accessed January 2009]

Couth R, Trois C. (2010). Carbon emissions reduction strategies in Africa from improved waste management: A review. University of KwaZulu-Natal, CRECHE, School of Civil Engineering, Survey and Construction, Durban 4041, South Africa.

Cointreau-Levine S. (1996). Sanitary landfill siting and criteria. Washington DC: World Bank Infrastructure Notes, Urban No. UE-12.

Dickerson, G. W. (1999). Solid Waste: Trash to Treasury in an Urban Environment. New Mexico Journal of Science. Nov.1999: 166.

Dunning R.D, Degner R.L, Von Blokland P.J. (1993). Municipal Solid Waste Composting: Issues Facing Communities. Florida Agricultural Market Research Center Staff Report 93-1

Ester van der Voet, Claudia B (2008). Applications of Material Flow Analysis, Journal of Industrial Ecology http://www.yale.edu/jie/cfpAMFA.htm [Accessed 06.Jan.08]

DCD (1999). A Citizen Guide to Municipal Service Partnerships.

Daskalopoulos E. et al. (1998). Resources, conservation and recycling 24 – Pg 155-166

De Jong J. (1999). Organizing waste reduction in the Dutch waste sector. Thesis. University of Amsterdam, Amsterdam.

Dickerson, G. W. (1999). Solid Waste: Trash to Treasury in an Urban Environment. New Mexico Journal of Science. Nov.1999: 166.

DFID (1999). Research development and design of a simple solid waste incinerator. Review of demand and selection of partner country. Intermediate Technology Consultants Limited (ITC). Contract No. CNTR 98 5698

Diaz, L.F, Savage G.M., Eggerth L.L. (2007). The management of solid wastes in economically developing countries. In: Diaz, L.F., Eggerth, L.L., Savage, and G.M. (Eds.), Managing Solid Wastes in Developing Countries. CISA Publisher, Padova, Italy, pp. 17–29.

Dongquing Z, Tan S, Gersberg R (2010). A comparison of municipal solid waste management in Berlin and Singapore. Waste Management 30, pp. 921-933

Delvoie C, Plessis-Fraissar M. (2005). Waste Management in China. Issues and Recommendations; World Bank: 2005

David, C. Costas, V. Cheeseman, C. (2006). Role of informal sector recycling in waste management in developing countries. Department of Civil and Environmental Engineering, Centre for Environmental Control and Waste Management, Imperial College, London, SW7 2BU, UK. http://previous.wiego.org/occupational_groups/waste_collectors/Wilson_Velis_Cheeseman_Informal_Sector_Waste.pdf [Accessed on 6.22.2013]

EPA (1994). Joining forces on solid waste management- Regionalization is working in rural and small communities.

EU Council (1999). EU Council Directive 1999/31/EC of April 1999 on the landfilling of waste Official. Journal of European Communities, http://europa.eu.int/eur-lex/lex/LexUrServ//LexUriServ.do? uri=CELEX:31999L0031:EN:HTM.

EPA (2002). Solid Waste Management: A Local Challenge With Global Impacts.EPA530-F-02-026 (5306W) Solid Waste and Emergency Response.www.epa.gov/globalwarming.

Evans E. (2002). "Measuring Success in Public Participation". International Association for Public Participation Conference Paper.

Evans D. et al.(2005). Bottom up and top down: Analysis of participatory processes for sustainable indictor identification as a pathway to community empowerment and sustainable environmental management. Journal of Environmental Management 78(2006) 114-127

FSD (2010). "Why Grassroots Development?" The Foundation for Sustainable Development. <http://www.fsdinternational.org/about/grassrootsdevelopment>. [Accessed May 2010]

Fatin S. et al. (2011). A review on the success factors for community participation in solid waste management. International Conference on management (ICM 2011) Proceeding. http://www.internationalconference.com.my/proceeding/icm2011_proceeding/070_260_ICM 2011_PG0962_0976_COMMUNITY_PARTICIPATION.pdf, [Accessed Feb.2012]

Global Waste Management Market Report (2007). Developing Integrated Solid Waste Management Plan Training Manual Volume 2 , Assessment of Current Waste Management System.UNEP,Osaka/Shiga, Japan http://www.unep.or.jp/ietc/Publications/spc/ISWMPlan_Vol2.pdf, [Accessed May 2012]

Hodgkins E.A (1990). "Technology Transfer in Selected OECD Countries," prepared for Federal Highway Administration, U.S. Department of Transportation, EAH & Associates, North Carolina, 1990

Habitat (1990). Human settlements and sustainable development; the role of human settlements and of human settlement policies in meeting development goals and in addressing the issuesof sustainability at global and local levels. United Nations Centre for Human Settlements. Nairobi, Kenya.

Hardoy, E.J. Miltin, D, Satterthwaite. (1992). Environmental Problems in Third World Cities. London: Earthscan Publications Limited. 304p. ISBN 1 85383 146 8.

Thomas (1999). What a waste: Solid waste management in Asia. World Bank, Urban and Local Government Working Paper 1. Washington, DC: World Bank.

Hershkowitz, A (2001). Dumping on paradise. Amicus Journal 23, no. 1, Spring 2001

Hogland W, Visvanathan C, Marques M, Manahdhar D.R. (2005). Filling the waste management gap: Landfill management in low- and medium income countries in Asia. The waste management world. pp 87-96

Haugestad, A. Wulfhorst, J. (2004). Future As Fairness: Ecological Justice and Global Citizenship: Household and institutional perspectives on solid waste management in Jamaica (pg 201) Ruby pap

Hempen, S (2005). Status and trends of residual waste treatment in Germany. In: Conference ‘‘The Future of Residual Waste Management in Europe, 17–18 November 2005”, Luxembourg.

Hisashi Ogawa. Sustainable Solid Waste Management in Developing Countries. http://www.gdrc.org/uem/waste/swm-fogawa1.htm [Accessed May 2012]

Hettiaratchi, J.P.A. (2007). New trends in waste management: North American perspective. School of Engineering, University of Calgary, Calgary, Alberta, Canada

Howes, S. (2009). “The White Man’s Burden: Why the West’s Efforts to Aid the Rest Have Done So Much Ill and So Little Good.”Economic Record (The Economic Society of Australia). 85.271 (2009): 488.)

Hogland et al. (2007). Sustainable Waste Management: International Perspectives. Proceedings of the International Conference on Sustainable Solid Waste Management,5 - 7 September 2007, Chennai, India. pp.1-8.

Hoornweg D, Thomas L, Otten L. (1999). Composting and its Application in Developing Countries. Urban Waste Management Working Paper Series 8. Washington, DC: World Bank.

Jensen L. (1991). Recycling in Cairo. WARMER Bulletin 29, 5.

Jeon E.J, Bae S.J, Lee D.H, Seo D.C, Chun S.K, Lee H, Kim J.Y. (2007). Methane generation potential and biodegradability of MSW components. In: Sardinia 2007 Eleventh International Waste Management and Landfill

John L S, William M. B (1998). Material flow and sustainability. USGS Fact Sheet FS-068-98, June 1998 …http://pubs.usgs.gov/fs/fs-0068-98/fs-0068-98.pdf, [Accessed Feb.2012]

JICA (2005). The study of solid waste management in Dhaka City. Clean Dhaka Master Plan, Final Report, Pacific Consultants International, Yachiyo Engineering Co. Ltd.

Isaacson R. (1991). Methane from community wastes. Elsevier science publishers Ltd.

Keeling JB. (1991). The recyclers of Harare. WARMER Bulletin 31, 4.

Kalbermatten JM, Middleton R.N. (1992). Future directions in water supply and water disposal. Washington, DC (draft report)

Kim P. (1998). Community-Based Waste Management for Environmental Management

and Income Generation in Low-Income Areas: A Case Study of Nairobi, Kenya, Mazingira Institute Nairobi, Kenya.

Kemajou A et. al. (2007). Is industrial development incompatible with constraints of industrial ecology in Cameroom?http://isjaee.hydrogen.ru/pdf/pdf/06-08/Kemajou_194.pdf, [Accessed March 2012]

Kurian J. (2007). Top down and bottom up approach for sustainability of waste management in developing countries. Vol.3. 1995

Kapoor R. (2009). Public Attitude towards Solid Waste Management- An Empirical Analysis. Proceedings of international conference on energy and environment.ISSN:2070-3740 http://www.cityfarmer.org/NairobiCompost.html [Accessed 16th Jan.2012]

Korfmacher, K. (2007). Solid Waste Collection Systems in Developing Urban Areas of South Africa: an Overview and Case Study. http://wmr.sagepub.com/content/15/5/477.abstract [Accessed on 20.06.13]

Les Robinson, Nolan-Itu (2002). Pro-active public participation for waste management in western Australia http://www.enablingchange.com.au/Pro-Active_Participation.pdf [Accessed May 2012]

Lowndes, Vivien Lawrence Pratchett, Gerry Stoker (2006a). "Local Political Participation: The Impact of Rules-in-use." Public Administration 79: 205-222

Lopes RF, Shan Muganantha S, Lippett R, Keir A, Mellos R, Hoornweg D (2007). Municipal solid waste management in the Latin American and Caribbean regions: trends and opportunities for improvement. In: Sardinia 2007 Eleventh International Waste Management and Landfill Symposium, October 2007, Santa Margherita di Pula, Cagliari, Sardinia, Italy.

Louigueur D. (2007). Private Sector Participation in Integrated Sustainable Solid Waste Management in Low- and Middle Income Countries. http://www1.unisg.ch/www/edis.nsf/SysLkpByIdentifier/3381/$FILE/dis3381.pdf [Accessed May 2012]

Lowndes, Vivien Lawrence Pratchett, Gerry Stoker (2006b). Diagnosing and Remedying the Failings of Official Participation Schemes: The CLEAR Framework. Social Policy and society5: 281-91

Liebenberg C.J (2007). Public Private Partnership solutions to waste management in developing countries in Africa. In: Sardinia 2007 Eleventh International Waste Management and Landfill Symposium, October 2007, Santa Margherita di Pula,Cagliari, Sardinia, Italy.

Lundström (2007). Sustainable Waste Management: International Perspectives. Proceedings of the International Conference on Sustainable Solid Waste Management, 5 - 7 September 2007, Chennai, India. Pp.1-8

Matthew V B (2005). Effect of state-level programs on waste reduction and increased recycling Vol.2, Spring 2005… http://web.mit.edu/murj/www/v12/v12-Reports/v12-r1.pdf [Accessed May 2012]

Medina M (1997) Scavenging on the boarder: a study of informal recycling sector in Laredo, Texas, and Nuero Laredo, Mexico. Ph.D Dissertation, Yale University.

Medina M. (2002). Globalization, Development, and Municipal Solid Waste Management in Third World Cities. http://www.gdnet.org [Accessed May 2012]

Medina M (2006). Achieving the MDGS through the informal recycling sector: A case study in Northern Mexico. CWG-WASH Workshops on solid waste, health and the Millenium Development Goals; Kolkata, India. Paper No. 10.

McCarthy JE (1993). Recycling and Reducing Packaging Waste: How the United States compares to other countries, Resources, Conservation and Recycling, No. 8, Elsevier Science Publishers, Amsterdam

Manga, V et al. (2007).Waste Management in Cameroon: A new policy perspective?

Mayet M (1993). Domestic Waste Generation in Urban Core of the Durban Functional Region. MSC Dissertation, University of Natal, Durban. P189.

McCarthy JE (1994). The municipal solid waste problem in the main industrialized countries. Congressional Research Service, The Library of Congress, Washington D.C. 20540, USA.

Muniafa M, Otiato E (2008). Solid waste management in Nairobi, Kenya. A case for emerging economics. In: WasteCon 2008, Nineteenth Waste Management Conference and Exhibition, October 2008, Cape Town, South Africa.

Mullingar Chamber of Commerce, Ireland (2003). Environmental Comparison Between Ireland and the EU Countries.

Mc Garity, T. (2005). Article entitled "Public Participation in risk Regulation", published on the internet arts.usask.ca/policynut/courses/mcgarity.htm., [Accessed May 2012]

Ngnikam E, Tolale E. (2009). Energy systems: Vulnerability – Adaptability – Resilience (VAR). Regional Focus: sub-saharan Africa Mitigation, Technology Transfer and financing http://hdru.aprc.undp.org/ext/HDRU/pdf/climate/Sub%20theme%205.pdf [Accessed Jan.2012]

Nicholas P. (2003). Handbook of Solid Waste Management and waste minimization technologies, Elsevier Science (USA)

NEA, MEWR (2006). Integrated solid waste management in Singapore. In: Asia 3R Conference, October 30–1 November, Singapore

OECD Seminar (1990). Section & technology Transfer Processes and Practices, http://onlinepubs.trb.org/ onlinepubs/ circulars/circ488/circ488_sect8.pdf, [Accessed May 2012]

OECD (2002). http://World Waste Management\EU\Environment-Waste_arquivos\Source OECD factbook_arquivos\08-02-02-g01.gif, (2002)

Ohnesorgen F (1993). Sorting out solid waste. Public Management, 9—12 March.

Onibokun A.G. (1997). Governing and urban waste in Africa's cities. Witwatersrand University Press, Johannesburg, South Africa.

Pearce D, Turner R (1994). Economics and solid waste management in the developing world. http://www.cserge.uea.ac.uk/sites/default/files/wm_1994_05.pdf [Accessed May 2012]

Pichtel J. (2005). Waste management practices, Municipal, Hazardous, and Industrial, Taylor and Francis Group, LLC

Putnam, Robert (2000). Bowling Alone: The Collapse and Revival of American community. New York: Simon and Shuster. Page B (2003) Communities as the agents of commodification: The Kumbo Water Authority in Northwest Cameroon. Geoforum 2003; 34(4):483–98.

Petkov M (1993). Avfallsströmmar I förändring – avfallsminimering i USA. USA 9311. Utlands Rapport fran Sveriges Tekniska Attacheer, November, ISSN 1100-2999

Palczynski R. (2002). Study on solid waste management options for Africa. Project report. The African Development Bank - PSDU July 2002

http://www.bscw.ihe.nl/pub/bscw.cgi/d1354356/SOLID%2520WASTE%2520MANAGEMENT%2520STUDY.pdf [Accessed May 2012]

Puentes C. (2004). Functional elements and human dimensions of a municipal solid waste management system in the Amazon forest: the case of Puerto Bermudez, Peru.

Pfeffer JT (1992). Solid waste management engineering. Prentis-Hall, Inc

Parry Geraint, George Moyser, Neil Day (1992). Political Participation and Democracy in Britain. Cambridge: Cambridge University Press.

Paul T. (1998). Waste treatment and disposal. John Wiley & Sons Ltd. Chichester, England

Palmer Development Group (1993). Backyard living in inner city townships: a survey of on-site access to water and waste services. Draft Report to the water research commission, Cape Town, S. Africa.

Poswa T (2004). The importance of gender in waste management planning: A challenge for solid waste management. Proceedings – 8th World Congress on Environmental Health. Durban, South Africa. ISBN: 0 9584663- 7- 8

Robinson D (1986). The solid waste handbook, a practical guide. John Wiley & Sons, Inc. USA

Rabinovitch J (1992). Curitiba: Towards sustainable urban development. Environment and Urbanization 4(2), 62-73.

Romanos M, Chifos C. (1996). Contribution of the Urban Informal Sector to Environmental management., Regional Development Dialogue, 17, 1, Spring 1996.

Richard G. k and Kelvin R (1998). Canadian Innovations in Siting Hazardous Waste Management Facilities. Environmental Management Vol. 22, No. 4, pp. 533–545, New York Inc.

Habitat (2006). Role of informal sector recycling in waste management in developing countries. Habitat International Vol. 30, 4-December 2006, pages 797-808

Ruby P. (1980). Household and institutional perspectives on solid waste. http://www.inter-disciplinary.net/ptb/ejgc/ejgc2/ejgc2pap.pdf [Accessed May 2012]

Rushbrook P, Pugh M. (1999). Solid waste landfills in middle and lower income countries. A technical guide to planning design and operation World Bank technical paper No.426, the World Bank Washington DC, 1999

Renkow, Rubin A.R. (1998). Does municipal SW composting make economic sense? Journal of Environmental Management (1998) 53, 339-347

Renkow M, Keeler A.G (1996). Determining the optional landfill size: is bigger always better? Journal of Enviromental Management 46, 67 – 75

Robson E. (1990). Cleaning up Mali – and making it pay. Source 2(4), 10-13

Schmitt R.P, Beimborrn E.A, Mulroy M.J (1985)"Technology Transfer Primer," FHWA-TS-84-226, University of Wisconsin, July 1985

Schubeler Peter (1996). Conceptual framework for municipal solid waste management in low-income countries. United Nations Development Program, UMP Working

Sohail, S. Rehan, A. (1996). Community Participation in Urban Solid Waste Management in Karachi (Pakistan) Case Study Report. Community Participation in Urban Waste Solid Management. WASTE UWEP.

http://www.globenet.org/preceup/pages/ang/chapitre/capitali/cas/pakist.htm, [Accessed on 18.06.13]

Smith, G. (2005). Power Beyond the Ballot: 57 Democratic Innovations from Around the World. London: The Power Inquiry.Paper Series no. 9. St. Gallen, Switzerland: SKAT.

Suchada P., Tränkler J et.al. (2003); The Role of Formal and Informal Sectors in Solid Waste Management of Development Countries; Proceedings Sardinia 2003: 9th international Waste management and Landfill Symposium S. Margherita de Pula, Calgary, Italy

Sadler C. (1997). Guidelines for the provision of Township Engineering Services and Amenities in Residential Township Development. Unpublished Discussion Document on Solid Waste Management. Rivonia: Bergman-Ingerop. 16p

Senkoro, H. (2003). Solid waste management in Africa: A WHO / AFRO Perspective. Paper 1, presented in Dar Es Salaam at the CWG Workshop, March 2003. Retrieved electronically: http://www.skat.ch/sf-web/activities/ws/cwg/pdf/cwg-01.pdf [Accessed May 2012]

Statistical Handbook of Japan (2003). Statistics Bureau, Ministry of Public Management. Home Affairs, Posts and Telecommunications, Japan Statistical Association, Japan.

Schnurer, H. (2002). German Waste Legislation and Sustainable Development: Development of Waste Legislation in Germany towards a sustainable closed Substance Cycle. Work shop organized by the Alexander von Humboldt Foundational, the International Institute for Advance Studies (IIAS), in Kyoto, Japan, 29 November–1 December, 2002.

SUCHADA, P. et al. (2003). The role of formal and informal sectors in solid waste management of developing countries. Proceedings Sardinia 2003, Ninth International Waste Management and Landfill Symposium S. Margherita di Pula, Cagliari, Italy; 6 - 10 October 2003

Spies S, Wehenpohl G. (2006). Informal sector in SWM, CWG on SWM in LMIC and WASH Workshop 2006, Kolkata/India, p.2

Tjell, C.J., A. Elmlud and J. A. Hansen (1981). Source or Central Separation of Household Food Waste in Bridgwater, A.V. and K. Lidgren (eds.). Household Waste Management in Europe (Economic and Techniques). Van Nostrand Reinhold Co. Ltd., New York.

Thomas-Hope E (ed.) (1998).Solid waste management: critical issues for developing countries. Kingston: Canoe Press.

Tchobanoglous G., Theisen H, Vigil SA (1993). Integrated Solid Waste Management: Engineering Principles and Management Issues. New York: McGraw-Hill.

Tchobanoglous G, Theisen H, Eliassen R (1977). Solid Wastes: engineering principles and management issues, 1977

Twardowska I (2004). Solid Waste: Assessment, Monitoring and Remediation. Waste Management Series**,** Volume 4, 2004, Pages 3–32

Tchobanoglous G, Kreith F, (2002). Handbook of Solid Waste Management, second ed. McGraw-Hill, ISBN 0-07-135623-1

UNEP (2005). Solid Waste Management, Volume II: Regional Overviews and Information Sources. United Nations Environment Programme (UNEP), 2005. Solid Waste Management,

vol. I, ISBN: 92-807-2676-5.

UNEP Environmental Data Report (1994). GEMS monitoring and Assessment Research Centre, London UK in co-operation with the World Institute, Washington DC, UK Department of the Environmental, London.

UNDESA (2005). Agenda 21- Chapter 21 Environmentally Sound Management of Solid Wastes and Sewage-related Issues. Division for Sustainable Development, United Nations Department of Economic and Social Affairs. http://www.un.org/esa/sustdev/documents/agenda21/index.htm [Accessed May 2012]

UNDP and the Urban Explosion: Crisis and Opportunities

http://www.un.org/cyberschoolbus/habitat/units/un06txt4.asp **[**Accessed December 2011]

UN (1998). O'Meara, M., New Version for Cities, in Freire, M./Stren R. (eds.), Urban Government, Washington: WBI, 2001, p. 340 (Cited from U.N. 1998)

UNDFW (1998). Gender and Telecommunications: An Agenda for Policy. A Documented prepared for the United Nations University for New Technologies (UNU/INTECH) and the United Nations Development Fund for Women (UNIFEM).

UNDP (2007). United Nations Millennium Development Goals. United Nations Development Programme, http://www.undp.org/mdg/ [Accessed May 2012]

UNEP (1996). International source Book on Environmentally Sound Technologies for Municipal SWM. UNEP Technical Publication

Vlachos, E. (1993). "North American Experiences with Public Participation". Colorado State University, Fort Collins, CO 80523. En contro sobre Consulta Publica no Proceso de Avaliação
Ambiental , 25 Maio 1993.

Van der Broek E, Kirov NY (1972). The characteristics of Municipal Solid Wastes. Solid Waste Treatment & Disposal, Ann Arbor Science Publishers, Ann Arbor, MI, USA.pp. 23-29.

Vesiland P.A, Rimer A.E. (1981). Unit operation in resource recovery engineering. Prentice Hall Inc., Englewood Cliffs, NJ, USA.

Vesilind, P Worrel W, Reinhart, D. (2002). Material flow. Solid waste engineering. Brooks/COLE . CA USA. Pg. 30-33 & 4-10

Varma Ajaykumar R. (2008). Technology Options for Treatment of Municipal Solid Waste with special reference to Kerala, Proceedings of Kerala Environment Congress, 2008.

Vaishali A (2009). Sustainable Urban Solid Waste Management – a case study of Pune. 10th National Conference on Technological Trends (NCTT09) 6-7 Nov. 2009 http://117.211.100.42:8180/jspui/bitstream/123456789/538/1/AR_06.PDF [Accessed May 2012]

Wapole R.E. (1982). Introduction to statistics. Macmillan Publishing Co., Enlewood Cliffs, NJ.

Williams P.T., (2005). Waste treatment and disposal.2nd ed. John Wiley & sons Ltd West Sussex England.

Warmer Bulletin 49 (1996). White P. So what is integrated waste management? Journal of the World Resource Foundation, Tonbridge.

World Bank (2002). Upgrading low income settlement country assessment report. Cameroon; 2002. http://web.mit.edu/urban%20upgrading/Upgrading/case-examples [Accessed on 30.05.10]

World Bank (2006). Africa Development Indicators 2006: From Promises To Results.

WASTE and SKAT (2007). "Economic Aspects of Informal Sector Activities in Solid Waste Management", Final Report (2007). Waste, Skat, Reference Number 81084644

Waste Framework Directive. (1975). Council Directive 75/442/EEC, OJ L 194, 25.7.75.

White P, Franke M, Hindle P. (1995). Integrated Solid Waste Management: A lifecycle Inventory. Blackie Academic and Professional, London.

World Bank (1999). Changing Gender Relations in the Household.

Wilson DC, Velis C et al. (2006). "Role of informal sector recycling in waste management in developing countries." Habitat International 30(4): 797-808.

Yedla S, Parikh JK (2002). Development of a purpose built landfill system for the control of methane emissions from municipal solid waste. Waste Management 22, 501-506.

Zerbock O (2003). Urban Solid Waste Management: Waste Reduction in Developing Nations

Zurbrugg C. (2003). Urban Solid Waste Management in Low-Income Countries of Asia: How to Cope with the Garbage Crisis. http://www.cepis.org.pe/bvsacd/cd48/crisis.pdf [Accessed May 2012]

Appendices

Appendix I

Table. A presentation of main constraints to waste management

Factors	Constraints
Institutional	Ineffective coordination of the solid waste management system.
	Lack of a coordinating body among the local government leads to disintegrated and unsustainable SWM programmes.
Legal/Policy/Planning	Lack of political will to implement policies and legal framework
Financial Resources	Inadequate financial resources allocated for solid waste management services. Waste management is not given a priority in budget allocation.
Technical Operations	Lack of accurate information on waste generation rate and composition
	Lack of ability for choosing appropriate technology collection, treatment and disposal.
	Limited capacity to operate most modern equipments for waste

	management.
Human Resources	Lack of effective coordination of human resources and capacity building. Short and long term plans are inadequate due to capital and human resource limitations.
Environmental Issues	Lack of suitable land for disposal of waste. Regular changing of waste disposal sites leads to more land pollution.
Socioeconomic	Low level of public participation, a result of limited environmental awareness, information and education.

Appendix II

Table II-1 Percentage of World Wide used waste disposal methods

Continent	Percentage of waste disposed by					
	Recycling	**Sanitary landfill**	**Open Dum**	**Incineration**	**Open Burning**	Others
Africa	3.9	29.3	47	1.4	9.2	8.4
Asia	8.5	30.9	50.9	4.7	1.7	4.5
Europe	10.7	27.6	33	13.8	11.8	4.4
N. America	8.1	91.1	0	0	0	0
Latin A.	3.2	60.5	34	2	5.5	2

Table II-2 Number of Recycling Industries in Mokattam, Cairo

Type	**Number**

Plastic crushing	65
Washing and sorting of plastics	6
Plastic granulation	15
Cloth grinders	17
Paper compaction balers	19
Tin cutting	29
Tin washing	2
Pelletizing	11
Recycling of other plastics	7
Injection Molding	44
Aluminum smelters	13
Total	**228**

Source: CID (2001). The informal Solid Waste Sector in Egypt: Prospects for Formalization. Cairo: Community and Institutional Development, 36

Appendix III

Table III-1 Classification of materials comprising municipal solid wastes

Type	Description
Garbage	Results from food marketing, preparation and consumption (also called food wastes). It contains putrescible organic material and will decompose

	rapidly, especially in warm weather. It needs special consideration due to its nature of attracting vermin and of producing very strong odours.
Rubbish	This category consist of paper and paper products, plastics, cans, bottles, glass, metals, ceramics, dirt, dust, yard and garden wastes, these materials are nonputrescible.
Ashes	This is the residue from any combustion process (i.e. fire places, wood or coal heating units etc.) resulting from household activities and on-site incineration.
Bulk wastes	This category includes furniture, appliances, mattresses and
Demolition & Construction	This class of refuse includes the lumber, bricks, concrete, plumbing, waste electrical wiring etc. associated with the destruction of old buildings and the construction of new ones.
Special wastes*	Wastes resulting from normal street cleaning operations, such as street sweeping, roadside litter, catch-basin debris, dead animals and abandoned vehicles
Treatment plant wastes	Include the solid and semi-solid wastes from water, waste water and industrial waste treatment facilities.

*Some authors classify special wastes as the hazardous solids and liquids, explosive substances, pathological wastes, toxic chemicals or radioactive materials generated by hospitals, research laboratories etc.

Source: Keshore Kumar Heeramun (Mauritius, 1993)[50]

Table III-2 General sources of municipal solid wastes

Source	**Typical facilities, activities or locations**	Types of solid wastes

[50] Solid waste management in Mauritius- An Alternative to sanitary landfill. Environmental Management in Developing Countries- Vol 2. 1995. Institute for Scientific Co-operation, Tübingen, Federal Republic of Germany.

	where wastes are generated	
Residential	Single-family, multi-family dwellings; low-,medium-, and high-rise apartments etc.	Food wastes, rubbish, ashes, special wastes
Commercial	Stores, restaurants, markets, office buildings, hotels, motels, demolition and construction, print shops, auto repair shops, medical facilities and institutions etc.	Food wastes, rubbish, ashes, wastes, special wastes
Open areas	Streets, alleys, parks, vacant lots, playgrounds, beaches, roads, recreational areas etc.	Special wastes, rubbish
Treatment plants	Water, waste water, industrial treatment processes etc.	Treatment plant residual sludge

Source: Peavy et al., 1988.[51]

Table III-3 General sources of municipal solid wastes

Source	**Typical facilities, activities or locations where wastes are generated**	Types of solid wastes
Residential	Single-family, multi-family dwellings; low-,medium-, and high-rise apartments etc.	Food wastes, rubbish, ashes, special wastes
Commercial	Stores, restaurants, markets, office buildings, hotels, motels, demolition and construction, print shops, auto repair shops, medical facilities and institutions etc.	Food wastes, rubbish, ashes, wastes, special wastes

[51] Peavy, H. S. et al: Environmental Engineering, 1988

Open areas	Streets, alleys, parks, vacant lots, playgrounds, beaches, roads, recreational areas etc.	Special wastes, rubbish
Treatment plants	Water, waste water, industrial treatment processes etc.	Treatment plant residual sludge

Source: Peavy et al., 1988.[52]

Table III-4 Comparison Of Typical Solid Waste Management Practices

Comparison Of Typical Solid Waste Management Practices			
Activity	**Low Income**	**Middle Income**	**High Income**
Source reduction	No organized programs, but reuse and low per capita waste generation rates are common.	Some discussion of source reduction, but rarely incorporated in to any organized program.	Organized education programs are beginning to emphasize source reduction and reuse of materials.
Collection	Sporadic and inefficient. Service is limited to high visibility areas, the wealthy, and businesses willing to pay.	Improved service and increased collection from residential areas. Large vehicle fleet and more mechanization.	Collection rate greater than 90 percent. Compactor trucks and highly mechanized vehicles are common.
Recycling	Most recycling is through the informal	Informal sector still involved some high	Recyclable material collection services

[52] Peavy, H. S. et al: Environmental Engineering, 1988

	sector and waste picking. Mainly localized markets and imports of materials for recycling.	technology sorting and processing facilities. Materials are often imported for recycling.	and high technology sorting and processing facilities. Increasing attention towards long-term markets.
Composting	Rarely undertaken formally even though the waste stream has a high percentage of organic material	Large composting plants are generally unsuccessful; some small-scale composting projects are more sustainable.	Becoming more popular at both backyard and large-scale facilities. Waste stream has a smaller portion of compostable than low and middles income countries.
Incineration	Not common or successful because of high capital and operational costs, high moisture content in the waste, and high percentage of inerts.	Some incinerators are used, but experiencing financial and operational difficulties; not as common as high income countries	Prevalent in areas with high land costs. Most incinerators have some form of environmental controls and some type of energy recovery system.
Landfilling	Low-technological sites usually open dumping of wastes.	Some controlled and sanitary landfills with some environmental controls. Open dumping is still common.	Sanitary landfills with a combination of liners, leak detection, leachate collection system, and gas collection and treatment

			systems.
Costs	Collection costs represent 80 to 90 percent of municipal SWM budget. Waste fees are regulated by some local governments, but the fee collection system is very inefficient.	Collection costs represent 50 to 80 percent of the MSWM budget. Waste fees are regulated by some local and national governments, more innovation in fee collection	Collection costs can represent less than 10 percent of the budget. Large budget allocations to intermediate waste treatment facilities. Upfront community participation reduces costs and increases options available to waste planners(e.g., recycling and composting

Source: World Bank[53], 1999

Table III-5 CLEAR: Factors Promoting Participation

Key Factor	How it Works	Policy Target
Can do	The individual resources that people have to mobilize and organize (speaking, writing and technical skills and the	Capacity building, training and support of volunteers, mentoring, leadership

[53] The International Bank for Reconstruction and Development/The World bank, 1999. What a Waste: SWM in Asia – Urban Development Sector Unit, East Asia & Pacific Region

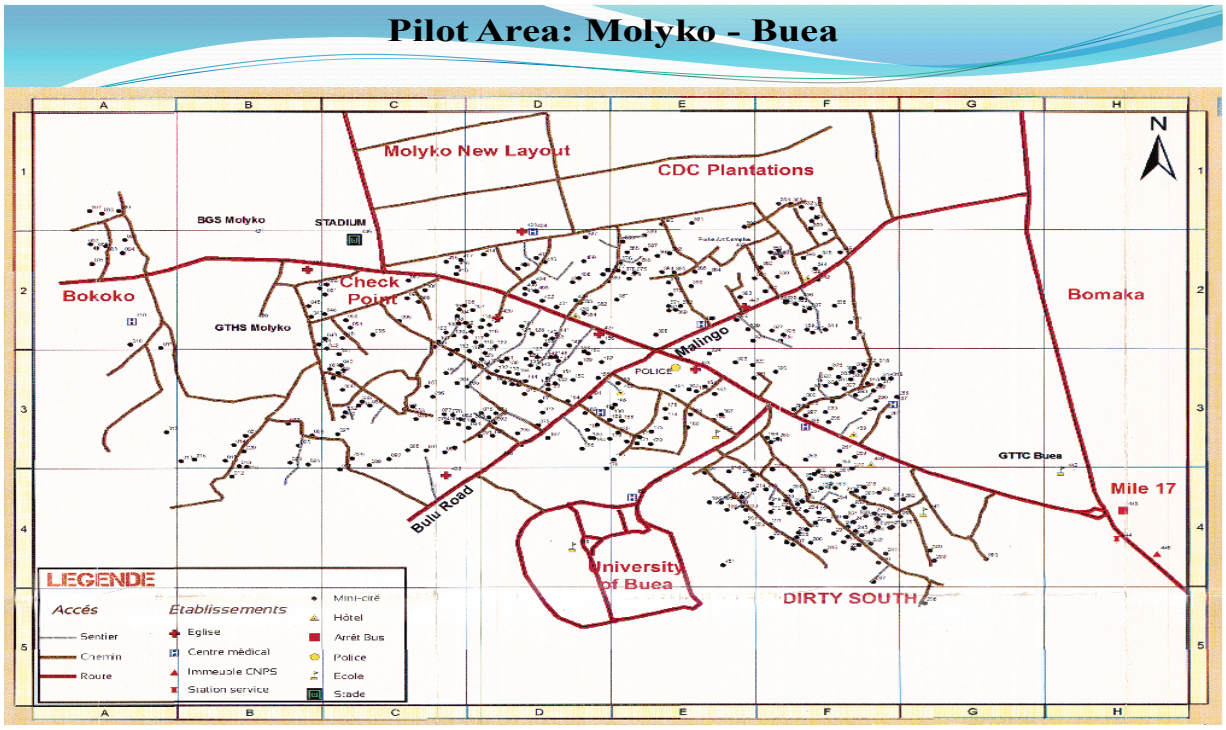
http://web.mit.edu/urbanupgrading/urbanenvironment/resources/references/pdfs/WhatAWasteAsia.pdf 28.02.12

	confidence to use them) make a difference.	development.
Like to	To commit to participation requires an identification with the public entity that is the focus of engagement	Civil renewal, citizenship, community cohesion, neighborhood working, social capital
Enabled to	The civic infrastructure of groups and umbrella organizations makes a difference because it creates or blocks an opportunity structure for participation	Investing in civic infrastructure and community networks, improving channels of communication via compacts
Asked to	Mobilizing people into participation by asking for their input can make a big difference.	Public participation schemes that is diverse and reflexive.
Responded to	When asked people say they will participate if they are listened to (not necessarily agreed with) and able to see a response	A public policy system that shows a capacity to respond – through specific outcomes, ongoing learning and feedback

Source: Lowndes et al. (……) Understanding citizen participation in Local Government – and How to Make it Work Better. Local Governance Research Unit, De Montfort University, Leicester, United Kingdom

Appendix IV

Figure IV Pilot Area



Numbe, J. (2009). City Mapping for Development

Table IV- Physical characteristics of solid waste (household) in Buea

Serial No.	**Components**	**% Weight**
1	Organic or Food waste	
2	Plastics	
3	Metals	
4	Paper & Cardboard	
5	Textiles	
6	Rubber & Leather	
7	Wood	
8	Bulk Waste	
9	**Others**	Insignificant

Waste generation rate:

Average waste generation per household (HAv.): done by adding all the measured weights and dividing the result by the number of households (sample size)

Per capita waste generation: HAv. /Av.Hm

Where Av.Hm = Average number of household members

Appendix V

Table V-1 Strategic situation for waste management communication

STAGE	(1)Developing a Regional IRR plan	(2) Siting and technology choice	(3)Implementing SRR	(4)Educating the public on using the new system
PURPOSE	Design of an integrated W.M strategy that is: (a)Triple bottom line sustainable; (b)Regionally specific; (c)Locally sensitive; (d)Internat'l best practice	A transparent, defensibleprocess which develops performance criteria that are: (a)Technically appropriate; (b)Socially sensitive;(c)Locally sensitive;(d)Financially sound;(e)Best practicable environmental option; and(f) Meets or exceeds international benchmarks.	Public trust is engendered through a process of independent, transparent monitoring of performance of facilities.	Residents understand and Participate in the new system, as typically measured by: (a)High participation rates; (b)Low contamination rates; (c)High diversion rates; and (d) Adoption of more sustainable lifestyle practices.

Source: Les Robinson 2002

Gender Dimension: CLEAR Framework

Table V-2

Participation Factors	**Indicative Set of Policy Responses**	**Results**	
		Yes	**No**
Can do	Women have the resources and knowledge to participate	**19**	**9**
Like to	have a sense of attachment that reinforces participation	**18**	**10**
Enabled to	are provided with the opportunity for participation	**19**	**9**
Asked to	are mobilized through public agencies and civic channels	**20**	**8**
Responded to	see evidence that their views have been considered	**20**	**8**
*	Women are directly concerned with WM in the home	**21**	**7**